HIGH TECHNOLOGY BUSINESS

NEW FUELS FOR CARS

DECEMBER 1987

$3.00

STAR WARS

- Where The Money's Going
- Exclusive Survey Of SDI Contractors
- The Top 6 Technologies
- Revenue By State

SDI's #1 Company: Lockheed

President Robert A. Fuhrman

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— Senator Philbert "Filibuster" Peabody

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HIGH TECHNOLOGY BUSINESS

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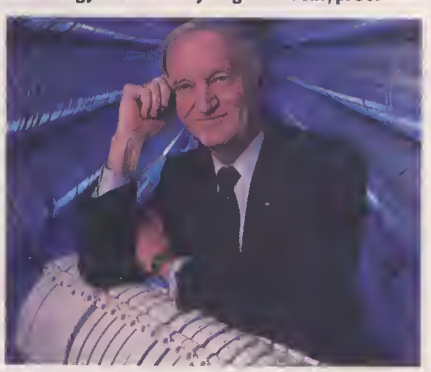

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Cover photograph by Greg Pease

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Mark J. Estren

Tracking Star Wars Dollars

The Strategic Defense Initiative. SDI. Star Wars. No matter what you call it, it's expensive—so far, it has cost taxpayers $7.3 billion. Another $5.2 billion in funding has been requested for next year. Eventually, the program will probably cost more than $100 billion.

HIGH TECHNOLOGY BUSINESS began research on this subject several months ago, after Senior Editor Herb Brody suggested looking into where all that money was going. Brody found that the money was not going to a handful of companies, but was being spread among more companies than in most defense programs. Extensive research led to this month's cover story, "Star Wars—Where the Money's Going," which begins on page 22.

The SDI program depends on technological developments such as free-electron lasers, kinetic-energy weapons, and space-based surveillance systems, and could prove to be key to future defense contracts. We wanted to know how companies that have received contracts to develop those technologies view the program's potential. To get the answers, HIGH TECHNOLOGY BUSINESS polled the heads of companies that have received more than $10,000 worth of Star Wars contracts (see "The Star Wars Survey," p. 25).

The survey showed that, although many companies are participating in Star Wars research, most are not heavily dependent on the program. However, a few companies have formed or acquired new divisions to deal with SDI work.

As to when SDI will be ready for deployment, more than half the corporate leaders surveyed said the date would be before the year 2000, whereas 21 percent said it would be later. Again looking to the future, slightly more than 40 percent think SDI funding will decrease under the next presidential administration.

You may wonder why SDI technologies matter to you. The answer: Most companies interviewed said they would find other markets for the technologies they are developing.

For example, the free-electron laser may hold potential as a medical tool. Infrared sensors and computers being developed to watch for attacking missiles could be applied to air-traffic control. The technology at the heart of high-energy lasers and particle-beam generators might be used to sterilize hospital supplies. More than half the company presidents surveyed rated the potential for commercialization of SDI-related technology as moderate to extremely high.

We hope this month's cover story gives you a scorecard of the players benefiting from SDI and helps you understand the program's technology and business implications.

Charles L. Martin Jr.

Ada Activity

MY CONGRATULATIONS on your recent analysis of trends in software development ("Military Software's New Market," September, p. 43). I agree with writer David Freedman's basic conclusions and would only add that it is clear that companies without the technical know-how or foresight to address and move to the "new market" will have significant difficulties in the future.

Peter Voletsky
Executive Vice President
SPS Software Products & Services
New York, New York

I READ WITH INTEREST the article "Military Software's New Market" in the September issue (p. 43). Although your list of the top 10 Ada companies outlines some of the major players, it failed to include another significant company—TeleSoft, which specializes in developing Ada technology, tools, services, and training. TeleSoft released the first commercial Ada compiler in 1981; our products are in use in more than 1,000 installations and 175 universities worldwide.

The article stated that "IBM has shown no intentions of selling . . . Ada-support products to outsiders," and also that Intermetrics has "had little competition providing units for IBM mainframes." This is not accurate. TeleSoft has been working under contract with IBM, developing Ada compilers and productivity tools for the 370 systems, since 1982 when those systems first became available. In September 1986, TeleSoft agreed to provide IBM with exclusive distribution rights to its TeleGen2 Ada compilers for the 370, and IBM is now selling these products.

The TeleGen2 Ada-development system is available from other computer makers, including Gould, Sun Microsystems, Symbolics, and Unisys. TeleSoft also offers development systems for DEC's VAX/VMS systems, and contracts with Cray Research and Prime Computer call for developing and distributing TeleGen2 products for their hardware.

In addition, TeleSoft is providing Magnavox with TeleGen2 products for use on the Advanced Field Artillery Tactical Data System, a project involving more than 750,000 lines of Ada code. TeleSoft has also been providing services to General Dynamics for projects involving the Mil-Std-1750A processor, which is used extensively in the avionics industry.

Bruce Sherman
Director of Marketing
TeleSoft
San Diego, California

High Tech, High Risk

IN HER COLUMN "The Startup Insurance Trap" (September, p. 19), Anne Simon Moffat discussed the prohibitive cost of starting a new high-tech small business. She mentioned exorbitant rates—as much as $90,000 for $400,000 worth of coverage.

Doctors, especially obstetricians and neurosurgeons, routinely pay this much in solo practice. In Florida, these specialists pay more than $200,000 per doctor for very limited coverage and have been paying comparable rates for 10 or more years. The higher the technology and training, the greater the risk. This is the future.

The tort explosion and the high cost of insurance will probably doom start-up businesses. The cost of insurance and litigation may make us noncompetitive internationally. Perhaps we can export our lawyers to Japan and destroy their economy.

Olav H. Alvig, M.D.
Cumming, Georgia

Faith Rewarded

THE ARTICLE BY Michael Leibowitz in your September issue ("Chip Takeover Targets," p. 21) provides a total misconception of Analog Devices' support of GigaBit Logic.

Analog Devices was the principal source of funding for GigaBit during its very difficult 1986 year. Also, Analog Devices was a major participant in the $15-million round of financing that GigaBit received in the spring of 1987. Indeed, we were instrumental in the decision by Digital Equipment and Cray Computer to invest in GigaBit by virtue of our strong support of the company and belief in its capabilities and future. The progress of GigaBit in 1987 and its momentum justifies our faith in the company.

Lawrence T. Sullivan
Senior Vice President
Analog Devices
Norwood, Massachusetts

The Heart of Innovation

OVER THE YEARS I have enjoyed your magazine because it gave me an overview of what was new in technology in the broadest sense. From my point of view, the heart of innovation is to learn of new advances that may have applications in medicine. Often, such applications come from unexpected places.

Although I understand that information processing is the cutting edge of technology, there are already many magazines that address the computer industry. But other aspects of electronics are neglected, such as sensing technology, display devices, and remote-control methods. The value of your magazine is not to address these subjects in the type of detail that would be found in a trade journal, but to make a person in another field aware that such a technology exists, facilitating innovation.

Lewis S. Solomon, M.D.
Santa Rosa, California

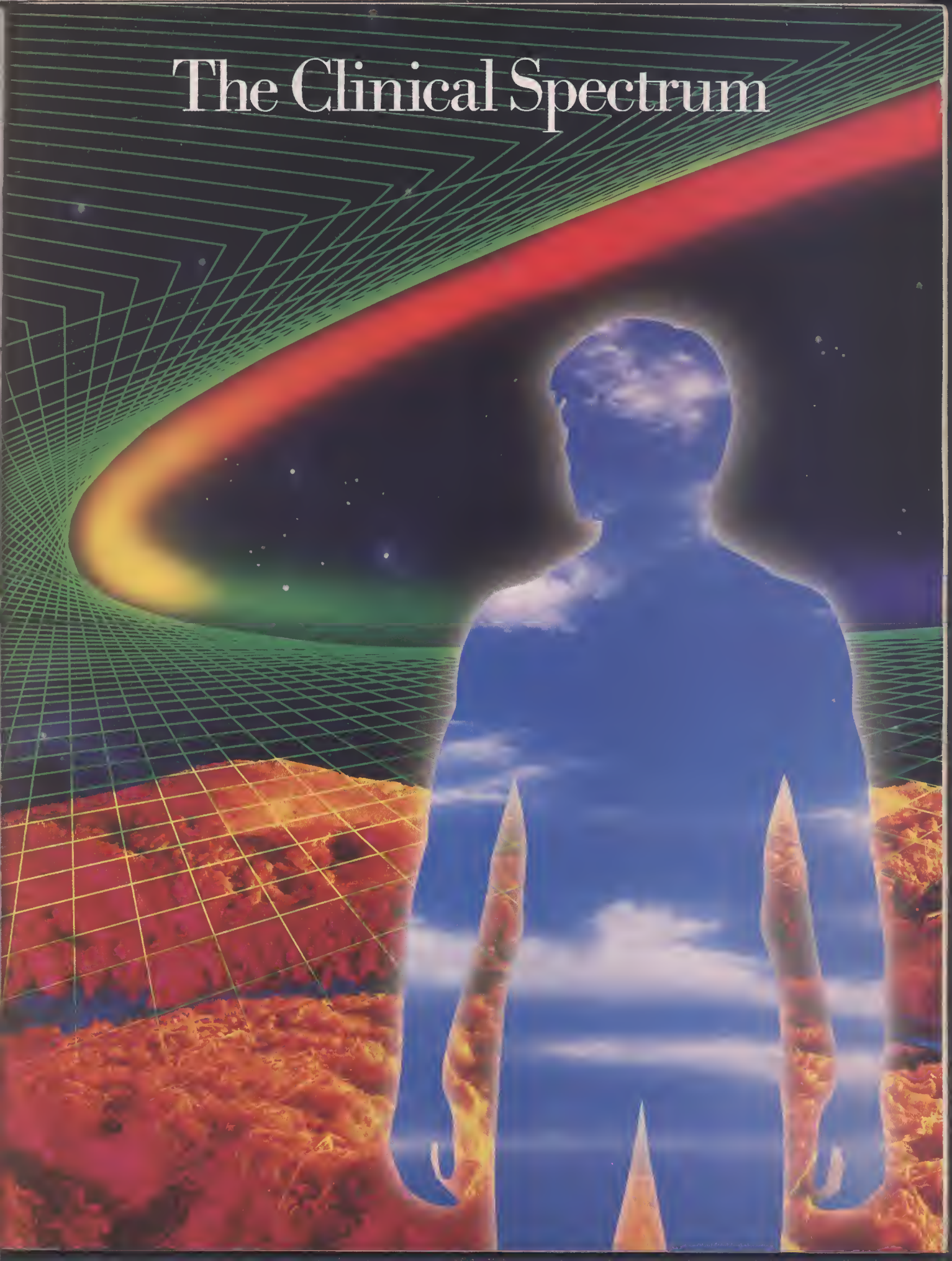
Change for the Better

AS A LONG-TIME reader of your magazine, I am pleased at the changes that were initiated in the September 1987 issue. I find particularly helpful the improved graphics, typified by the "Smart Cards" article and the "At a Glance" tables in the special report on chip takeover targets.

Howard L. Schultz
Vice President, Operations
Insight Datasystems Inc.
Newton, Massachusetts

We welcome comments from our readers. Address letters to Editor, HIGH TECHNOLOGY BUSINESS, 214 Lewis Wharf, Boston, MA 02110. We reserve the right to edit letters for length and clarity.

The Clinical Spectrum



The Clinical Spectrum

Medical diagnoses sometimes depend on the ability to trace or detect minute amounts of biological species. Now researchers at the General Motors Research Laboratories have developed a method of spectrometry using a tunable diode laser that could lead to simpler, less costly, non-invasive diagnostic techniques.

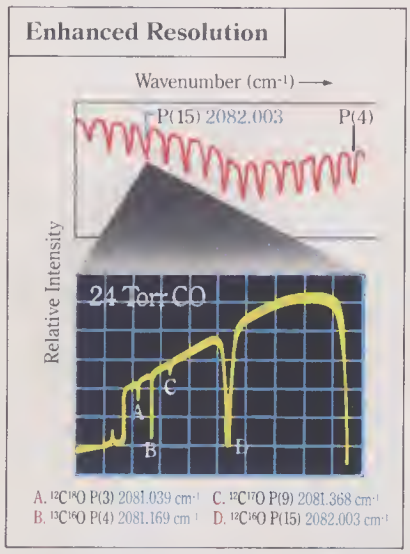
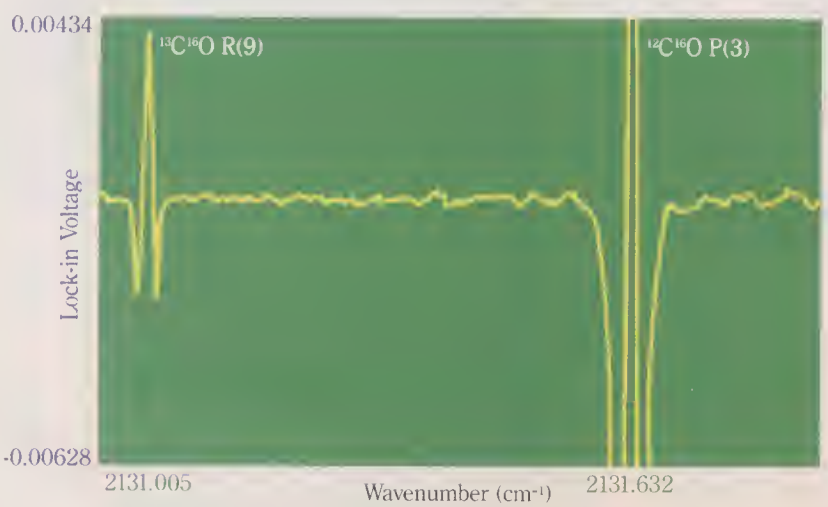


Figure 1: (Top) The absorption spectrum of CO obtained with a conventional spectrometer showing the P series rotation-vibration transitions separated by about 4 cm⁻¹. (Bottom) The diode laser spectrum centered at $^{12}C^{16}O$ P(15) region showing the complete resolution of $^{12}C^{17}O$ P(9), $^{12}C^{18}O$ P(3) and $^{13}C^{16}O$ P(4) transitions.

Figure 2: The second harmonic detection of the $^{13}C^{16}O$ and $^{12}C^{16}O$ as naturally present in exhaled human breath.



Carbon monoxide in exhaled human breath.
The scale has been expanded to show the excellent signal-to-noise ratio for $^{13}C^{16}O$. Other than removal of water vapor, no specific sample preparation or separation was needed.

In the process of living and growing, the body routinely takes in chemicals in the air we breathe and the food we eat, uses them, and converts them into other chemicals. These chemical activities, therefore, are often very good indicators of the health of the body or of its individual systems. The detection and measurement of particular chemical species is also of value in environmental, scientific and engineering studies.

Radioactive isotopes of elements in these chemicals have been extensively used as tracers. Many investigations, however, preclude their use either because no suitable radioisotope is available, or because radiation exposure raises health or environmental concerns.

The use of stable, non-radioactive isotopes for detection and tracing predates that of radioisotopes. But routine application of stable isotopes has been hindered by the lack of a detection method as versatile and simple as the scintillation counting used for radioisotopes. Mass spectrometry is the traditional method of detection of stable isotopes, but it requires extensive sample preparation, expensive equipment, and a highly trained operator to distinguish and measure chemically different molecules of the same nominal mass—nitrogen gas $^{14}N^{14}N$ and carbon monoxide $^{12}C^{16}O$, for example.

It was this need for high resolution and greater versatility that prompted Dr. Peter S. Lee and Richard F. Majkowski to develop a system for stable isotopic tracer analysis based on the molecular absorption of infrared light. A tunable, single-mode diode laser, developed originally by the Physics Department of the General Motors Research Laboratories to measure automobile exhaust gases, was used as the IR emitting source in what has proved to be a remarkably sensitive spectrometer.

The infrared absorption spectrum of molecules normally consists of transitions between series of vibration-rotation energy levels. When an atom in a molecule is replaced by an isotope of the same element, there is a shift in the energy levels due to a change in mass. The resulting frequency shift in the transitions forms the basis of the laser spectroscopic analysis system.

In the case of carbon monoxide, for example, there are six possible forms of the molecule involving stable isotopes: $^{12}C^{16}O$, $^{12}C^{17}O$, $^{12}C^{18}O$, $^{13}C^{16}O$, $^{13}C^{17}O$, and $^{13}C^{18}O$. Consequently, there would be six sets of overlapping spectral lines. Within a region of 1 cm⁻¹, there can be lines from several isotopic molecules, with as little as 0.1 cm⁻¹ or

less between adjacent lines.

This adjacency presents no problem for a diode laser system. The spectral resolution (the laser linewidth) is typically better than 10^{-4} cm^{-1}, which is orders of magnitude less than the isotopic line spacings. Since the diode laser is tunable, it can be centered in a region where the absorption lines of several isotopic molecules can be scanned within a single longitudinal laser mode (Figure 1).

In the initial experimental system, the source of the monochromatic IR radiation was a diode laser, made out of a single crystal containing layers of doped lead telluride and a lead-europium-selenium-telluride alloy. The IR light was collimated through a cell containing the sample to be studied and then focused onto an IR detector.

The cell was designed to have two optical path lengths that can be varied so that isotopic molecules with vastly different abundances can be determined from the measurement of the incident and transmitted laser intensities. U.S. Patent 4,684,805 covers this spectroscopic detection system.

The laser system can be made extremely sensitive using wavelength modulation and harmonic detection. Figure 2 shows the detection of $^{13}C^{16}O$ in exhaled human breath, where $^{13}C^{16}O$ is naturally present at a typical level of 1 to 10 parts per 100 million.

The present system can be used to measure stable oxygen isotopes in biological and organic samples that can be converted into CO. However, the method is applicable to any sample that can be converted into a gas with a suitable IR absorption spectrum.

"The use of radioisotopes as tracers is already well established," says Dr. Lee. "The potential is just as great for stable isotopes if more versatile analytical methods are made readily accessible.

"Packaged as a simpler, relatively inexpensive instrument, a tunable laser IR system could be adapted to many clinical tests—for fat malabsorption, ileal dysfunction, small-intestine bacterial overgrowth, alcoholic cirrhosis and liver function, lung function, nutritional assessment, and diabetes, to name a few.

"Diabetes could be diagnosed from the lung exhalate of a subject who had been fed a stable isotopically tagged sugar sample. No taking blood, no long waits, no radiation health and safety concerns.

"Simpler isotopic tracer measurements could broaden the scope of tracer methodologies, could supplement some of the radioisotope studies now common, and could have significant economic implications."

THE MEN BEHIND THE WORK

Dr. Peter S. Lee (right) is a Senior Staff Research Scientist in the Biomedical Science Department at the General Motors Research Laboratories. He received his undergraduate degree in Chemistry from the National Taiwan University. Dr. Lee also holds a Ph.D. in Physical Chemistry from the University of Illinois at Urbana-Champaign. His current research interests at GMRL include the study of biosensors and laser spectroscopy along with his work in stable isotopes. Dr. Lee came to GM in 1977 from the University of Illinois Medical Center in Chicago.

Richard F. Majkowski was, at the time of the work described here, a Staff Research Scientist in the GMRL Physics Department. Both his B.S. and M.S. degrees are from the University of Detroit in Physics and Mathematics. His research interests have included emission spectroscopy, coherent optics, holography and laser spectroscopy. Dick joined General Motors Research Laboratories in 1955 and retired in September, 1987, to become a Professor of Physics at Lawrence Institute of Technology.

New Developments

Issues, products and advances that help create new opportunities for high-tech businesses

- Telephone bill-paying systems try a comeback
- Artificial hearts take a turn for the better
- Laser process makes computer designs a reality

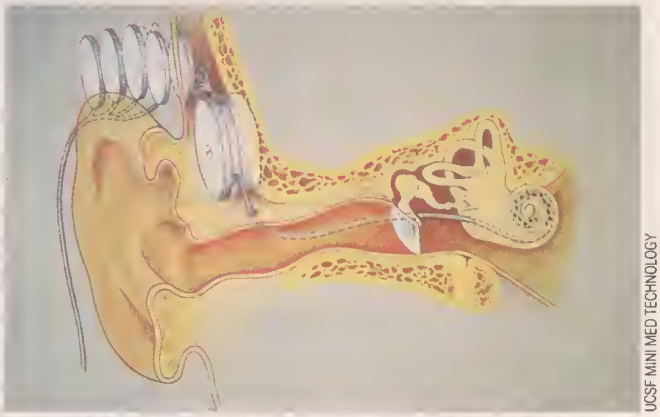
New Ears For The Deaf

ARTIFICIAL EARS for the deaf should improve substantially in the next year as more sophisticated multichannel units reach the market.

The devices, called cochlear implants, are far more than hearing aids; they replace the ear's sound-detection mechanism and send impulses to the brain. The simplest devices, already on the market, use one channel and produce an effect similar to a monotone. More sophisticated multichannel units, still under development, will offer better performance. Single-channel devices cost about $8,000; multichannel versions are $10,000 to $12,000. Surgical implanting costs $3,000 to $4,000, but Medicare and most insurance plans cover the combined cost for the more than 250,000 people in the United States who suffer from serious hearing loss.

Most observers expect multichannel ears to quickly put the single-channel units out of business beginning as soon as next year, depending on how quickly clinical trials proceed.

3M Corp. of Minneapolis has received FDA approval to market its single-channel device, and has sold more than 2,000 units. The company is working on a multichannel unit. Another approval-winner is Cochlear Corp., a subsidiary of Australia's Nucleus Devices. Its Nucleus-22 Channel grossed $5 million in sales in 1986, and the company expects to double that this year.



UCSF MINI MED TECHNOLOGY

Not a hearing aid, a cochlear implant replaces part of the ear.

Symbion Devices of Salt Lake City, better known as the maker of the Jarvik artificial heart, is not far behind. Its four-channel device is in clinical trials. MiniMed Technology, owned by Pacesetter Systems of Sylmar, Calif., also is working on a multichannel implant.

Good News for Plastics Makers

PRODUCERS OF plastic and organic chemicals may soon be able to replace expensive imported ethylene and acetylene with cheap and plentiful methane. An inexpensive new process turns waste methane into the raw materials needed by plastics manufacturers.

Methane gas, gathered from natural gas and sewage-treatment sites, offers a cheap and secure alternative to oil-derived sources of the ethylene and acetylene used to make advanced plastics and organic chemicals. The process could begin cutting costs for plastics producers within five years.

The new process could save plastics producers 15 percent of the 24-cents-per-pound cost of ethylene derived from petroleum, according to a study by Kinetics Technology International of Monrovia, Calif. The process, called chlorine catalyzed oxidative pyrolysis (CCOP), was patented by Senkim Senkan, an associate professor of chemical engineering at the Illinois Institute of Technology in Chicago. Plastics producers used five billion pounds of ethylene in 1984, and observers

expect total usage to reach approximately six to eight billion pounds in 1995.

Developed with funding from the Environmental Protection Agency, CCOP chlorinates the methane and adds oxygen before sending it to a chamber heated to 1,000 degrees Centigrade.

Value Boost for Patents

THE FEDERAL government is showing a new enthusiasm for moving publicly sponsored inventions into the private sector. A recent licensing decision on a new alloy created at the Department of Energy's Oak Ridge National Laboratory in Tennessee bodes well for the market value of government patents.

Detroit-based Armada Corp. recently won an exclusive license to make heating coils from a nickel-aluminide alloy that defies metallic convention—when heated, the alloy gets stronger instead of weaker. This could lead to more compact, less expensive appliances in as few as two years.

Because the new alloy doesn't sag after prolonged use as most heating coils do, it doesn't need as many support structures. As a result, appliances using coils made of the new alloy would cost less to manufacture.

The exclusive license shields Armada from immediate competition. Until recently, government-invented technology was offered to any company that wanted it—an egalitarian approach that negated the market value of government patents. The Energy Department does make one claim on the new alloy; it will collect royalties to help pay for further technology-transfer efforts.

A New Look at 3-D

THE HISTORY of three-dimensional images is checkered with overblown expectations, from the red-and-green glasses needed to watch *It Came From Outer Space* in the 1950s to holograms in the 1970s and 1980s. But a new process promises to give 3-D another shot at stardom.

The new technique replaces the usual side-by-side images with alternating stereoscopic pictures on a television's screen. Unfortunately, this process, which was pioneered by JVC several years ago, produces an annoying flicker effect. Liquid-crystal eyeglasses, which blank out the appropriate eye 60 times a second in synch with the TV's scanning rate, help eliminate the problem.

Toshiba has just introduced a dual-lens, portable video camera-recorder that uses this technique to shoot and record 3-D color pictures on VHS-C cassettes. Viewers watch the image on a standard TV, but must wear glasses tethered to the VCR. Toshiba hopes to unveil the new device in Japan early next year, and in the United States in the third quarter of 1988. Meanwhile, Japan's Sega Enterprises Ltd. has introduced a $49.95 enhancement for its home video-game system. Sharp, Casio, Citizen, and Sanyo are also reported to be working on liquid-crystal 3-D systems.

TOSHIBA AMERICA INC.

Toshiba's new 3-D video camera.

According to technology consultant Mark Schubin, 3-D holds potential in robot vision and nuclear-materials handling, computer-aided design and manufacturing, X-ray imaging, and security—as well as in entertainment.

An Air Bag In Every Car

COMPANIES that produce collision-activated air bags are preparing for brisk business come 1990. That's when federal law requires automakers to equip all of their five million new cars with some sort of passive restraint system on the driver's side. Because air bags are relatively simple, they are the device of choice. Current systems cost as much as $1,200, but prices could drop as low as $300 once production begins.

For the three companies that have sewn up the air-bag market in the United States—Morton Thiokol, Talley Industries, and TRW—the new regulation assures success.

Talley is building a new plant in Mesa, Ariz., that will turn out about 2.5 million air-bags each year, and the company says it can double that capacity. Talley is the exclusive air-bag supplier to General Motors, which is expected to need 3.2 million driver-side bags by 1992.

Morton Thiokol, the air-bag source for West Germany's Daimler-Benz, is rumored to be close to becoming Chrysler's major supplier. Morton expects its new plant in Ogden, Utah, to make 1.5 million modules annually by 1990.

TRW, the world's leading supplier of seat belts, recently created a subsidiary, TRW Vehicle Safety Systems, to handle its burgeoning occupant-restraint business. Its first major deal is a long-term contract to supply all of Ford's restraint systems.

FORD MOTOR COMPANY

On impact, air bags inflate and deflate in less than a tenth of a second, protecting drivers from injury.

HAL MAYFORTH

Pay-By-Phone Tries Again

PAY-BY-PHONE, which lets customers pay bills by dialing a few digits on the phone, may be coming back. After making a splash in the 1970s, the error-prone early systems were hard to use and hard to find. Pay-by-phone programs accounted for just 6 percent of bill-paying options last year, but new computerized services introduced this year may restore some of the concept's faded luster.

Merchant Network of Arlington, Ill., has introduced a computer-aided system called Bill, used by customers at 140 branches of 36 Chicagoland banks. For $10 a year, customers can pay as many as 63 merchants and utilities. Customers tap into the system through a touch-tone phone and enter their account number and billing information; the bank sends a check to the billing party on the date requested.

In Tampa, Fla., Consumer Payment Services began testing its CPA system last January. This system lets customers belong to several banks, but charges 50 cents per payment. The company is marketing the system through participating banks. VideoFinancial, a subsidiary of AMR (which owns American Airlines), also offers a pay-by-phone service.

The new services will bump heads with the survivors of pay-by-phone's first go-round, including Commercial Federal Savings in Omaha, Neb.; Checkfree Systems in Columbus, Ohio; and People's Savings in Bridgeport, Conn.

MARK ANTMAN/IMAGE WORKS

Fiber Optics Fight Pollution

FIBER OPTICS has found a new use in environmental testing. University researchers are developing a fiber-optic system to continuously monitor groundwater for contamination. Industrial sites, landfills, and environmental agencies could use the system to track hazardous chemicals as they invade streams, lakes, and water supplies.

The system is still in the embryonic stage, but John Gilbert and James Smith at the University of Alabama in Huntsville hope to complete it by 1989. They have applied for a $250,000 federal grant to finish development. Gilbert says several environmental-sensing-equipment companies have approached him about the technology, but no deals have been struck. He expects the system to create an annual market of several million dollars.

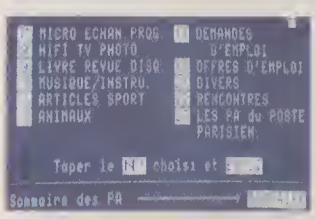
A typical use for the testing system would run optical fibers along the layer of sediment that water permeates before reaching a well, then connect the fibers to chemical sensors inside the well. To check for contamination, environmental officials or plant employees would send laser light through the fibers. When a chemical comes in contact with the fiber, it changes the frequency and intensity of the light; a meter connected to a personal computer reads the changes to identify the chemical and its concentration. Costs would range from a few thousand dollars to about $100,000.

Ideally, the system would be installed during construction of landfills or industrial facilities, but mobile systems would allow field testing.

Phone Decision Echoes

SMALL companies that provide information services may benefit from the September court decision that would let the regional Bell telephone companies carry, but not create, information services.

The decision by U.S. District Court Judge Harold Greene permits the seven Baby Bells to provide "gateway" service for information providers, including data transmission, address translation, protocol conversion, and billing management. The regionals also will be able to publish electronic versions of the white-pages directories. But the decision bans them from the most important new markets—they still may not provide information services, enter the long-distance market, or manufacture equipment.



France's Minitel system is the model for U.S. information services.

The ruling frustrates the Bell companies, which had hoped to expand into new businesses. The decision also brings new doubts about the FCC's Open Network Architecture concept, which would let the Bell companies provide information services if they opened their networks to third-party users.

But long-distance companies such as AT&T, MCI, and US Sprint breathed a sigh of relief that they won't have to face seven new well-financed competitors. The biggest winners are expected to be small, consumer-oriented information services, which will be able to use the Bell-owned public network to deliver their services but will not have to worry that their carrier may decide to compete with them. The ruling should thus encourage inexpensive new options for casual users, much as France's Minitel system offers access to hundreds of electronic information services over the public telephone network.

Shortcut to Reality

ENGINEERS take for granted the ability to whip up designs on a computer screen. Now, a pair of laser techniques developed at a small Chicago company can rapidly transform these snazzy displays into three-dimensional objects. The laser processes avoid the lengthy

and expensive task of fabricating a mold, and can be used to produce small batches of complex parts.

Michael Feygin, president of Hydronetics, expects aerospace and medical prosthesis applications to push revenue to $100 million within four years.

Hydronetics constructs objects layer by layer. In one approach, the computer-driven laser cuts out hundreds of cross-sections from pieces of sheet metal; these slices are then stacked and laminated to form a 3-D object.

A second method, still in the research stage, extends the concept beyond metals. A laser melts part of a base of compressed powder, which then resolidifies to form a structure.

Artificial Hearts Beat On

DOCTORS AND medical-technology companies around the world are racing to fulfill the promise of the artificial heart.

In one of the most innovative schemes, Dr. Jean-Raoul Monties, chief of surgery at France's University of Aix Hospital's Marseille branch, has devised a heart that uses a rigid rotating pump to circulate blood. The French government is funding research on the new heart, dubbed Cora, which may have its first human tests by 1990.

Like many in the new generation of artificial hearts, Cora is designed to free patients from the cumbersome external power source needed by the Jarvik heart. Cora runs on a 6½-pound battery worn on the patient's belt. The elliptical rotor eliminates the need for entry and exit valves to the ventricles and lets Cora last longer than previous devices.

France's Cora rotary heart.

FRENCH TECHNOLOGY PRESS OFFICE INC.

Several U.S. companies are also working on portable artificial hearts. Cardiac Systems in Philadelphia (with Temple University Hospital) and Sarns/3M of Ann Arbor, Mich., are working on hearts with external pumps. Simbion of Salt Lake City (with the University of Utah) is refining the Jarvik design, and Penn State's Hershey Medical Center is developing an electric, motor-driven heart that can be completely implanted.

These products will compete for a multi-billion-dollar market. Estimates of the number of candidates for the artificial hearts, which cost $15,000 to more than $50,000, range from 35,000 to 60,000 people per year.

ALSO WORTH NOTING

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Elograph's touchscreen.

■ Most touchscreens can sense where a user touches them, but a new product from Elographics can tell how hard it's been pushed. The IntelliTouch screen uses surface-acoustic-wave technology to add pressure coordinates—a Z axis—to the standard vertical and horizontal X and Y axes of earlier touchscreens. The IntelliTouch, which is sold to resellers as a transparent glass overlay, detects 16 levels of pressure, and its controller card can be programmed to offer different responses to each level. Pushing harder, for instance, might raise the sales bar on a business-growth chart. According to Elographics, which is based in Oak Ridge, Tenn., the product can be used in process control, public information systems, instrumentation control, and the military.

■ Major plastics manufacturers are joining with the Battelle Memorial Institute in Columbus, Ohio, to study waste-plastic disposal and recycling. Current disposal techniques are expensive and environmentally questionable; recycling is incomplete. Although some plastics can be melted and reused, others lose essential characteristics in the process. Finely ground waste plastic can be reused as plastic filler and some polymer composites can be rejuvenated, but many plastic wastes have no recycling potential. Along with Battelle, the plastics companies will spend $300,000 over the next 15 months to develop alternate solutions.

■ The first commercial software program to model groundwater contamination should be out next year. Funded by the Water Resources Center and the UCLA School of Engineering, the program simulates the flow of organic materials into wells and lets researchers test ways to contain contaminants. Large organizations have created their own models for some time, but the commercially available system will make the technique available to users with fewer resources.

■ Advanced ceramics may soon provide the aerospace, automotive, laser, and semiconductor industries with new materials for developing aircraft, shatterproof glass, and car engines that don't need cooling systems. Materials manufacturers are looking to the sol-gel process, a low-temperature method of mixing composites in a jelly-like substance, to provide fade-proof ceramics that withstand temperatures higher than 5,432 degrees Fahrenheit. UCLA professor John MacKenzie has taken this process a step further, suspending inexpensive diamond dust in sol-gel material to create a nonconductive insulator ideal for manufacturing semiconductors and integrated circuits. Under development with funds from the Air Force Office of Scientific Research, the new materials should be available next year.

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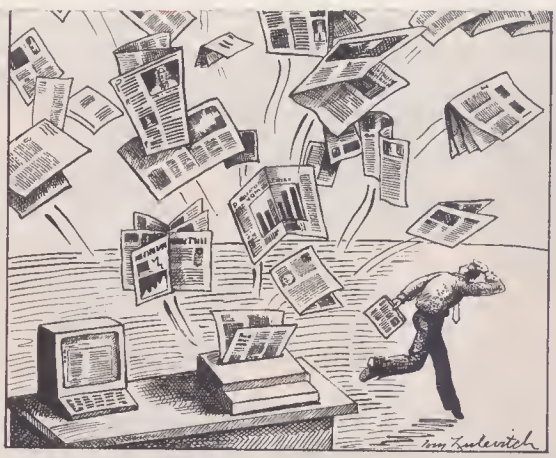
but a mixture of hardware and software pieces. It combines hardware, a page-description language that tells output devices how to print a page, and a software package that, for the most part, lets a user take text and graphics files created elsewhere and shape them into a document that, theoretically speaking, looks as if it were professionally produced.

But how realistic is this proposition? Can a person who has little or no background in typography and graphic design really turn out the same quality of work that a graphic-arts department or shop can? The answer is, probably not—at least not with today's technology. The real test will come in the next year or two, when the graphic-arts experts apply their experience and abilities to the pieces and parts that make up desktop publishing.

For some perspective on the issue, consider the original version of the WordStar program. In the early days it was the most popular word-processing package around. It ran on the smallest systems available and it worked. People complained about it, but they also bought it and used it. Only with increases in the speed and memory of personal computers did the word-processing experts of the world—people who came from the Wang, Lanier, NBI, and IBM environments—begin to develop serious, full-function software based on their own experiences with what is



TOM LULEVITCH

This won't happen quickly—certainly not this year or the next. First, people need the horsepower to handle the complexities of a fully functional graphic-arts package. The advent of high-quality design also must wait until the experts transfer their knowledge to inexperienced designers through the use of more and better artificial intelligence, more on-line help, and more communication about what it takes to produce good desktop work.

Until then, they must be satisfied with the tools already available and those coming in the next few months. Typical of the products and advances coming soon to a desktop near you are:

■ A color printer from QMS and Adobe Systems that produces fine-quality color output and has the potential to set the standard for color. Scheduled for release in the first quarter of 1988, this

[illegible] itors that present crisper monochromatic images and are more responsive to shading details.

■ Technical publishing software for the Macintosh II that will be compatible with Sun, Apollo, DEC, and IBM RT systems. Scheduled for November release by Interleaf, this software will let users coauthor a long document even if they use five different types of hardware. Of particular significance to cost-conscious desktop publishers is the price—$2,495, compared to $10,000 to $15,000 for software tailored for any of the other four hardware systems.

■ Enhanced page-description languages that will provide a true match between what appears on screen and what prints on the page; many systems now provide only a close approximation on screen. For example, Apple cofounder Steven Jobs' new company, Next Inc., has been working for 18 months with Adobe Systems on a product that is expected to be available in the summer of 1988.

Yes, desktop publishing is a fad. But advances such as these promise that this fad will forever change both the way corporations communicate and the accepted standards for how all corporate documents should look. ■

Andrew M. Seybold is editor-in-chief of Andrew Seybold's Outlook on Professional Computing, *a monthly newsletter.*

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The Desktop Publishing Fad

NEW CORPORATE PUBLISHERS NEED EXPERT HELP

■ **By Andrew M. Seybold**

EACH GENERATION of personal computer has been driven by products from software makers. The Apple II got a very large boost from VisiCalc; the IBM PCs had help from Lotus 1-2-3 and its imitators. Recently it has been Apple's turn again with desktop-publishing programs.

Unlike VisiCalc and Lotus, desktop publishing is not one program but a mixture of hardware and software pieces. It combines hardware, a page-description language that tells output devices how to print a page, and a software package that, for the most part, lets a user take text and graphics files created elsewhere and shape them into a document that, theoretically speaking, looks as if it were professionally produced.

TOM LULEVITCH

But how realistic is this proposition? Can a person who has little or no background in typography and graphic design really turn out the same quality of work that a graphic-arts department or shop can? The answer is, probably not—at least not with today's technology. The real test will come in the next year or two, when the graphic-arts experts apply their experience and abilities to the pieces and parts that make up desktop publishing.

For some perspective on the issue, consider the original version of the WordStar program. In the early days it was the most popular word-processing package around. It ran on the smallest systems available and it worked. People complained about it, but they also bought it and used it. Only with increases in the speed and memory of personal computers did the word-processing experts of the world—people who came from the Wang, Lanier, NBI, and IBM environments—begin to develop serious, full-function software based on their own experiences with what is needed in the word-processing field.

So will it be with desktop publishing. As more experts enter the personal-computer world, more of the knowledge that has been developed by generations of graphics designers will enter the public domain, and more people will have the tools they need to produce documents that look as if they have been professionally designed and produced.

This won't happen quickly—certainly not this year or the next. First, people need the horsepower to handle the complexities of a fully functional graphic-arts package. The advent of high-quality design also must wait until the experts transfer their knowledge to inexperienced designers through the use of more and better artificial intelligence, more on-line help, and more communication about what it takes to produce good desktop work.

Until then, they must be satisfied with the tools already available and those coming in the next few months. Typical of the products and advances coming soon to a desktop near you are:

■ A color printer from QMS and Adobe Systems that produces fine-quality color output and has the potential to set the standard for color. Scheduled for release in the first quarter of 1988, this printer is said to be the first in a series of products.

■ An intelligent color-image printer from Tektronix that offers some of the functionality of the printer mentioned above at a substantially lower price. Available now, this printer costs $8,490 (with the minimum configuration of four megabytes of random-access memory) or $12,500 (with 12 megabytes of such memory).

■ High-resolution gray-scale monitors that present crisper monochromatic images and are more responsive to shading details.

■ Technical publishing software for the Macintosh II that will be compatible with Sun, Apollo, DEC, and IBM RT systems. Scheduled for November release by Interleaf, this software will let users coauthor a long document even if they use five different types of hardware. Of particular significance to cost-conscious desktop publishers is the price—$2,495, compared to $10,000 to $15,000 for software tailored for any of the other four hardware systems.

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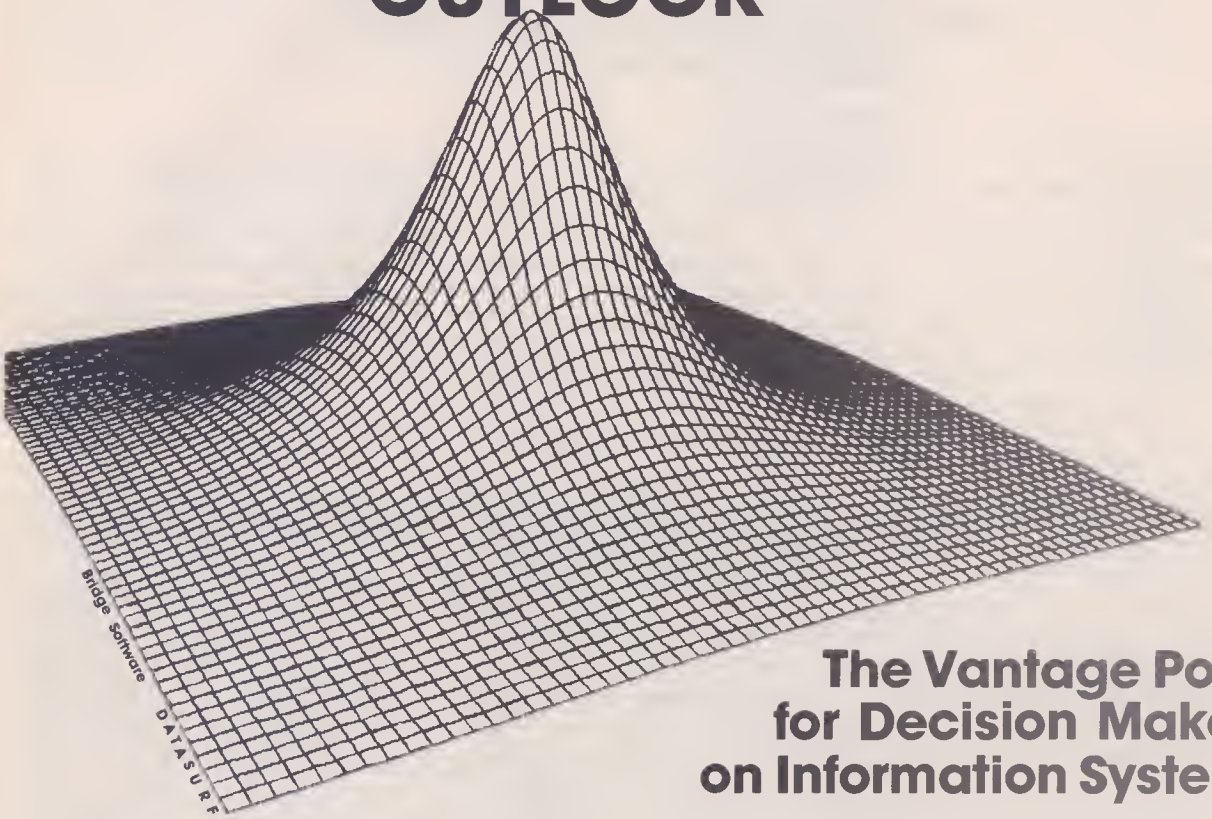
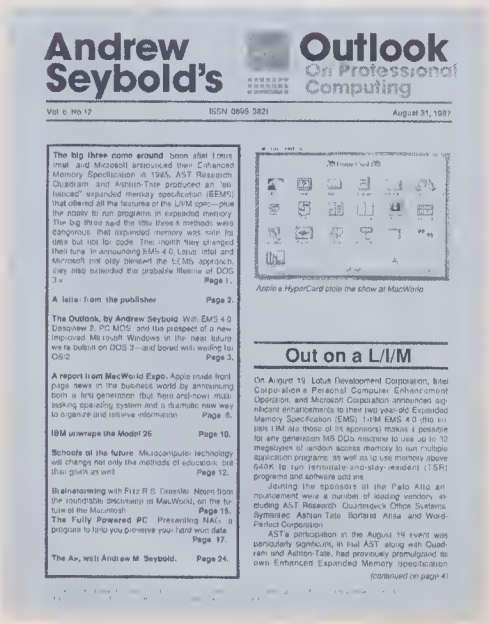
Andrew M. Seybold is editor-in-chief of Andrew Seybold's Outlook on Professional Computing, *a monthly newsletter.*

ANDREW SEYBOLD'S OUTLOOK



The Vantage Point for Decision Makers on Information Systems



Andrew Seybold's Outlook On Professional Computing

Vol 6 No 12 ISSN 0896 3821 August 31, 1987

The big three come around. Soon after Lotus Intel and Microsoft announced their Enhanced Memory Specification in 1985, AST Research Quadram and Ashton-Tate produced an "enhanced" expanded memory specification (EEMS) that offered all the features of the LIM spec—plus the ability to run programs in expanded memory. The big three said the little three's methods were dangerous that expanded memory was safe to use but not for code. This month they changed their tune. In announcing EMS 4.0, Lotus Intel and Microsoft not only blessed the EEMS approach, they also extended the probable lifetime of DOS 3.x. Page 1.

A letter from the publisher Page 2.

The Outlook, by Andrew Seybold. With EMS 4.0 DesqView 2, PC-MOS and the prospect of a new improved Microsoft Windows in the near future we're bullish on DOS 3—and bored with waiting for OS/2. Page 3.

A report from MacWorld Expo. Apple made front page news in the business world by announcing both a next generation (but here and now) multitasking operating system and a dramatic new way to organize and retrieve information. Page 6.

IBM unwraps the Model 25 Page 10.

Schools of the future. Microcomputer technology will change not only the methods of education but their goals as well. Page 12.

Brainstorming with Fritz R.S. Dressler. Noted from the roundtable discussion at MacWorld, on the future of the Macintosh. Page 15.
The Fully Powered PC. Presenting NAG, a program to help you preserve your hard won data. Page 17.

The Ax, with Andrew M. Seybold. Page 24.

Apple's HyperCard stole the show at MacWorld.

Out on a L/I/M

On August 19, Lotus Development Corporation, Intel Corporation a Personal Computer Enhancement Operation, and Microsoft Corporation announces significant enhancements to their two year-old Expanded Memory Specification (EMS). 1+IM EMS 4.0 (this stands for IM are those of its sponsors) makes it possible for any generation MS DOS machine to use up to 32 megabytes of random access memory to run multiple application programs as well as to use memory above 640K to run terminate-and-stay-resident (TSR) programs and software add ins.

Joining the sponsors at the Palo Alto announcement were a number of leading vendors, including AST Research Quadram's Office Systems Symantec Ashton Tate Borland Arlac and WordPerfect Corporation.

AST's participation in the August 19 event was particularly significant, in that AST along with Quadram and Ashton-Tate, had previously promulgated its own Enhanced Expanded Memory specification

(continued on page 4)

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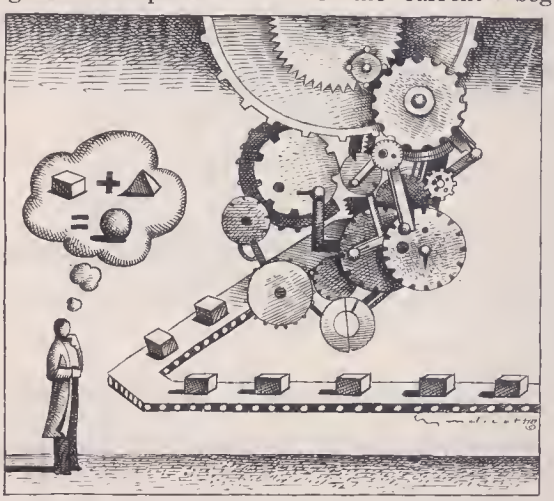
Assembly Lines Build Ideas

MANUFACTURING EXCELLENCE AIDS CREATIVITY

■ **By Robert Chapman Wood**

JAPAN WATCHERS have long lauded the attention Japanese companies pay to manufacturing. However, the advantages of that attention to process transcend the process itself. In Japan, manufacturing produces ideas as well as products.

A host of recent Japanese technological advances—in video recorders, semiconductors, ceramics, and laser printers, for example—arose primarily from the dogged pursuit of manufacturing excellence, not from money poured into research and development.



JAMES ENDICOTT

The video recorder is a classic example of how production know-how can yield important technical advances. Sony, along with Matsushita Electric and its partner, Japan Victor Corp. (JVC), redesigned a professional-use product from the United States that cost $20,000 or more and turned it into a $1,500 home product with a relatively small market. Japanese designers then worked closely with Japanese factories to make every component smaller and less expensive.

Cooperation between Matsushita's design teams and employees on the shop floor eliminated more than three-quarters of the product's cost while dramatically improving its quality. In the process, the company turned a niche product into the mass-market success story of the 1980s.

Japanese companies such as Toshiba, Hitachi, and NEC employed a similar process to dominate the market for dynamic random-access-memory chips, or DRAMs. Constant incremental improvements in quality, rather than dramatic new technology, cut costs for these manufacturers.

Some engineers at Toshiba predict that similar superior quality-control will eventually enable them to defeat U.S. companies in the microprocessor market. These engineers base their optimism on the fact that microprocessor design typically involves dozens of generations of prototypes. Because Japanese prototypes have fewer defects than U.S. prototypes, Japanese design teams can progress from generation to generation much faster than their U.S. counterparts can. NEC—the current Japanese leader in this area—Toshiba, and the TRON consortium are thus challenging such U.S. leaders as Intel and Motorola.

Japanese manufacturing excellence threatens to outmaneuver U.S. technology in ceramics as well. "In making a ceramic knife, the key point is good control over time and temperature in processing," says Myron Tribus, a quality consultant and former director of MIT's Center for Advanced Engineering Study. "Tokyo Electric has now introduced the first ceramic turbines, which are much more efficient than conventional turbines. The whole trick in making a ceramic blade for a turbine is the manufacturing know-how."

Even technological breakthroughs often depend as much on manufacturing ability as on research. Although laser printers for computers produce much higher-quality print than that of dot-matrix printers, they depend on an essentially simple technology that requires tremendous precision.

"Anybody can do it if they spend a lot of money," says Tribus of the process. "But the Japanese manufacture it for peanuts. That's incredible."

Japanese product designers typically begin their careers in their companies' factories, which ensures excellent communication between designers and factory people. Designers have access to factories' statistical quality-control records, project-by-project quality-improvement programs, and feedback from factory personnel who participate in value-analysis teams. This key information, which either doesn't exist in most U.S. companies or isn't circulated to top management, allows many tiny, incremental improvements that increase quality and decrease costs.

Although many U.S. companies, notably in the auto industry, have made progress in narrowing the Japanese manufacturing advantage, most U.S. technology executives still tend to neglect the manufacturing process, perhaps because it often represents only a small portion of the final cost of an advanced product. U.S. companies that want to reduce capital costs often subcontract much of their manufacturing, which further isolates it from key executives. Consequently, U.S. executives often know little about the procedures used to make their products.

Without feedback from the factory, improvements can't make the jump from factory floor to boardroom. U.S. executives would be well advised to pay as much attention to the assembly line as to the bottom line. ■

Robert Chapman Wood is a writer and business consultant who has specialized in the Orient for more than 12 years.

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Patents vs. Public Interest

COURT RULINGS MAY PROMPT RESEARCH SECRECY

■ **By Cynthia Robbins-Roth**

THE INVESTMENT community has been hard put to place a value on future sales by biotechnology companies. One reason is that in many cases where several companies are competing to bring the same product to market, there has been no clear sign as to which company will hold dominant patent rights.

Companies have lured scientists from academia by letting them publish the results of their research on first-generation drugs before patent applications have been filed for products based on that research—so-called second-generation drugs. As a result, competing companies have been able to use that original research in their work on second-generation products. Companies have fought back in court, claiming that their first-generation patents cover subsequent derivatives.

MARK KSENIAK

Recent action may provide clues to the scope of claims that the U.S. Patent Office and courts will allow. So far, court decisions seem to imply that broad patent claims covering both first- and second-generation products will not be granted unless the company applying for the patent demonstrates that it actually knows how to make second-generation drugs.

For example, the British High Court's decision this summer to revoke San Francisco-based Genentech's British patent on the blood-clot-dissolving protein TPA has been interpreted to mean that product claims will not be granted for the genetically engineered form of a protein that is already well known in its natural state. The judge also ruled that although the company discovered a new way to make TPA, it did not show how to make derivatives and thus had no exclusive right to those derivatives. In other words, although a company might patent a new route from New Jersey to New York City, it can't get a patent on New York City.

Also this year, U.S. District Court Judge William Schwartzer ruled that Genentech was infringing on a patent issued to Scripps Clinic for a method of obtaining Factor VIII:C—used to treat hemophiliacs—by purifying human blood. Because many hemophiliacs have contracted AIDS through contaminated Factor VIII:C preparations, a source of genetically engineered Factor VIII could be extremely valuable.

Scripps and its licensee, Rorer Group Inc. of Fort Washington, Pa., claimed that Genentech infringed on its patent by researching ways of creating Factor VIII using recombinant DNA. Scripps has filed similar suits against Chiron Corp. and Baxter Travenol. Although Judge Schwartzer ruled that Genentech had infringed on Scripps' patent, he allowed Genentech to continue work on the product. His reason could be important to other biotech companies; he held that because of the urgent need to find a genetic Factor VIII, the public interest would be better served if other companies could continue research on such a product while Scripps pursues its patent claims in the courts.

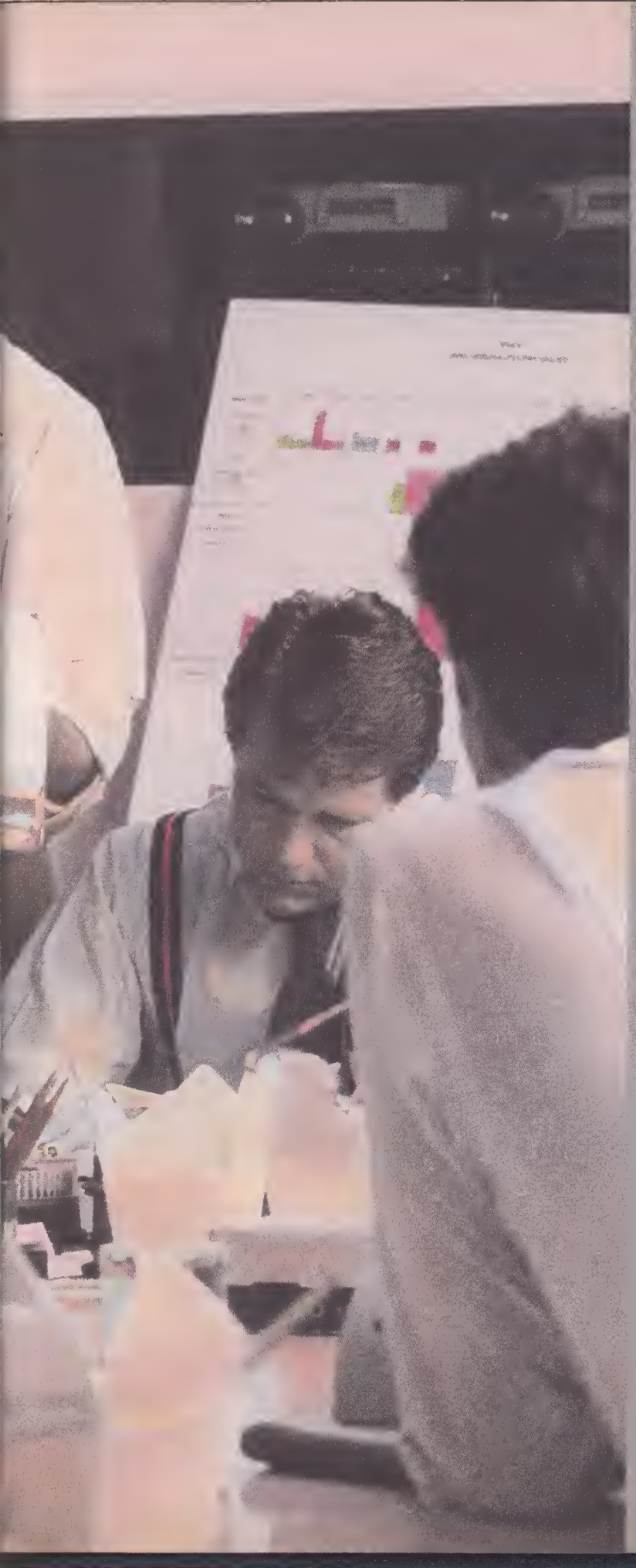
Amgen of Thousand Oaks, Calif., may benefit from this precedent if Genetics Institute of Cambridge, Mass., tries to stop Amgen's testing of erythropoeitin (EPO), a substance that helps treat the anemia associated with kidney failure. Even though Genetics Institute's patent appears to cover all forms of EPO, Amgen is believed to be at least two years ahead of Genetics Institute in developing it, and the product is expected to play a critical role in future earnings for both companies.

The biotech community had hoped the Scripps case might resolve questions about legislation that says research on generic drugs done to gain FDA approval does not infringe on existing patents. Genentech argued that the law, known as the Hatch-Waxman Act, also covers such new nongeneric drugs as Factor VIII:C. The judge denied Genentech's request, saying it violated the law's intent, but did not directly rule that the law applies only to generic drugs.

Again, Amgen has a significant stake in this issue. A decision that the law applies to new drugs could shelter the company's EPO clinical trials as well as its interleukin-2 program, which hopes to create a recombinant-DNA protein that activates the immune system to fight tumors. The program is under fire from Cetus Corp. of Emeryville, Calif., and could prove the next opportunity for a decision on the issue.

From the few court rulings so far, it seems biotech companies will have to keep research secret until second-generation products have been developed and patented—or risk letting a judge decide that the public interest outweighs patent rights. ■

Cynthia Robbins-Roth is editor-in-chief of the newsletter BioVenture View *and has a Ph.D. in biochemistry.*



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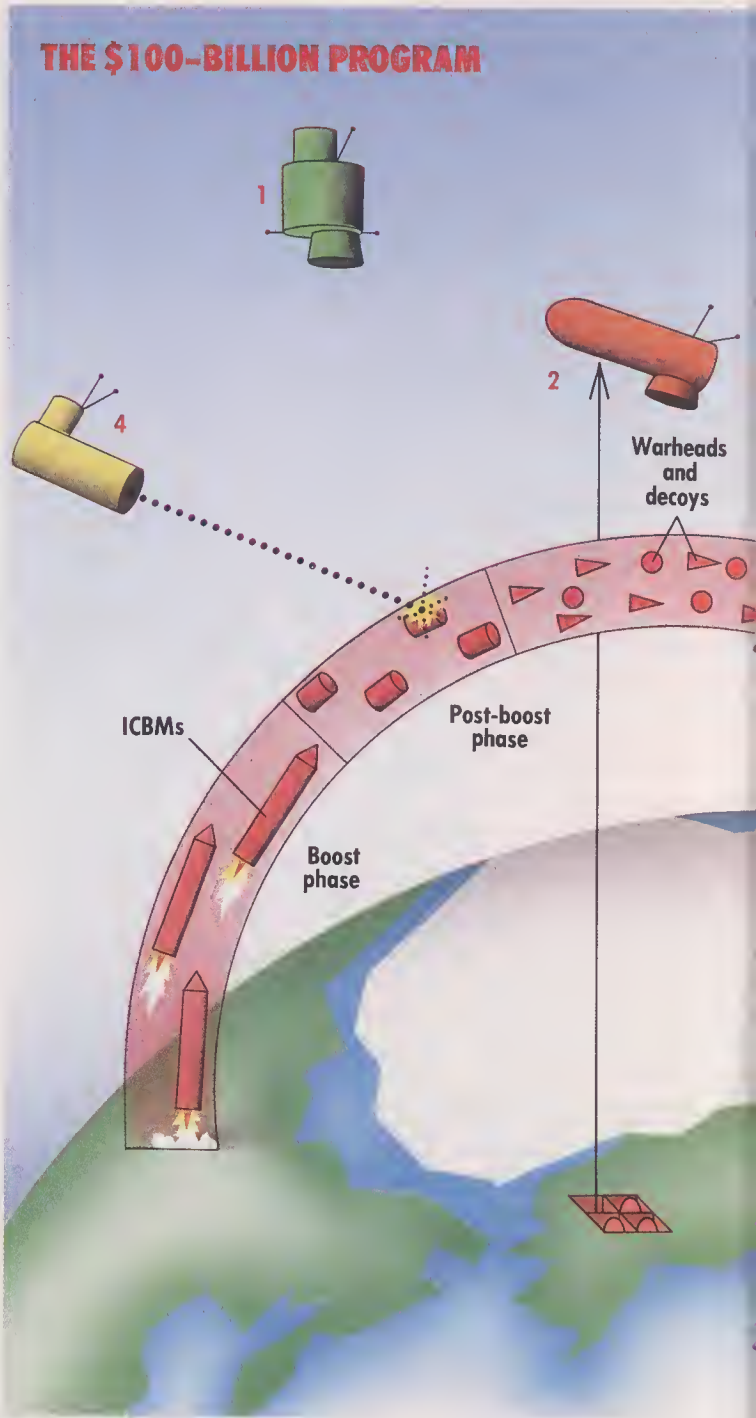
Star Wars

Where the Money's Going

As SDI shifts from research to acquisition, large companies increase their share of the funding

BY HERB BRODY

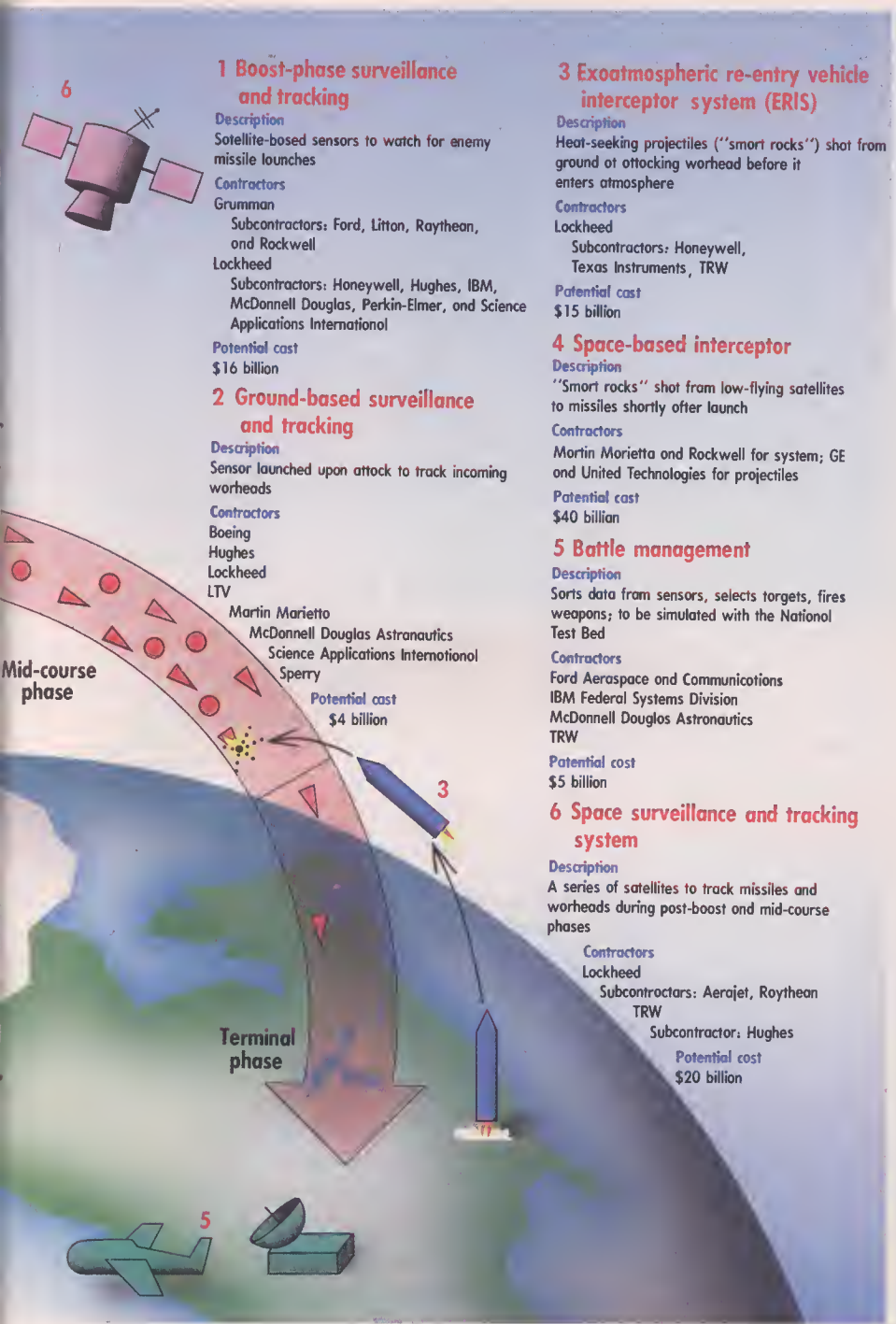


TO PROPONENTS, it's a strategic—and moral—imperative. To detractors, it's a hideous and unworkable boondoggle. But there's one point about the "Star Wars" program no one disputes: there's a lot of money in it.

The Strategic Defense Initiative (SDI) has gobbled up $7.3 billion since it attained institutional status in 1984. The Reagan administration is requesting $5.2 billion for fiscal 1988. Congress will probably chop that by a billion or so, but the program will still eventually cost more than $100 billion. Right now, SDI represents only about 1.5 percent of the Defense Department's total budget, though that share may rise to nearly 10 percent over the next decade.

For industry, the ramifications are clear. "SDI is the major window into new military research-and-development funding," says Byron K. Callan, a defense analyst with Prudential-Bache Securities. A HIGH TECHNOLOGY BUSINESS survey (see "The Star Wars Survey," p. 25) found that some firms are creating divisions or acquiring companies to boost their SDI capabilities.

Officially, SDI is purely research; development, testing, and deployment would violate the 1972 Antiballistic Missile (ABM) Treaty. Until now, SDI has



SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH/OEAN WITTER REYNOLDS

stayed true to its mission of exploring the technology's feasibility—whether the thing will work.

That task consists of large numbers of small experiments. Such early laboratory work matches the capabilities of many organizations, not just the aerospace giants such as Lockheed and Rockwell. SDI funds are being divvied up by a far larger assortment of companies than is typical for military programs. The Star Wars gusher has drenched (or at least sprinkled) more than 500 for-profit companies, according to the Federation of American Scientists. Money has gone also to roughly 100 universities and 100 nonprofit organizations, according to the federation, an anti-SDI group whose figures on SDI contracts are nonetheless used by such major defense contractors as TRW.

SDI officials hope research will give them enough information about various technologies to decide by the early 1990s whether to build a system that could be deployed by the mid-1990s. As a result, Department of Defense planners are starting to focus the program more closely. In September, Defense Secretary Caspar Weinberger approved a recommendation by the Defense Acquisitions Board (a group of military and civilian officials that assesses the progress of major weapons systems) to begin what the military refers to as "demonstration and validation" of six technologies. These technologies will move from the laboratory into the initial stage of a lengthy acquisition process—the first systems to do so—and will receive about half the SDI annual budget for the next few years.

Despite the glamour and controversy surrounding Star Wars, the program is not really new to the defense community. Virtually all the programs lumped under the SDI umbrella existed in some form before President Reagan's March 1983 speech calling for research on technologies that would render nuclear weapons "impotent and obsolete." The Army, Navy, and Air Force as well as the Defense Advanced Research Projects Agency (DARPA) sponsored work on many SDI technologies throughout the 1970s. Indeed, few major defense contractors will say outright that Reagan's initiative has led to any increase in revenue. During this pre-SDI period, companies such as Boeing, Rockwell, and Lockheed assembled impressive capabilities in the key Star Wars technologies: high-energy lasers, particle-beam generators, and devices that sense infrared radiation.

However, SDI differs from traditional military programs, according to defense analysts. "There's never been this much money going to early concept studies," says William Deatherage of Dean Witter Reynolds. Indeed, companies that specialize in leading-edge engineering research—such as BDM, Logicon, Kaman Sciences, and Nichols Research—have had SDI money "raining on their roof," says Prudential-Bache analyst Callan.

JOE LERTOLA

San Diego-based Titan Corp. has achieved exceptional success in the SDI contract game. Paced largely by Star Wars funding, Titan's revenues have grown at a compounded annual rate of 18 percent in the last four years. The company's more than $30 million in current SDI contracts hold potential for

ROCKY THIES

Gerold Yonas, once SDI's chief scientist, now heads fast-growing Titan Technologies.

more work worth as much as $270 million, according to Montgomery Securities, a brokerage firm that follows the company.

Titan has strengthened its position by buying small research companies that cover the gamut of strategic-defense technologies: Pulse Sciences, Spectron Development Laboratories, and Beta Development. What's more, Titan recently gained an edge by hiring Gerold Yonas—formerly chief scientist and acting director of SDI—as president of the company's Titan Technologies unit. The SDI organization has requested contract bids from Titan on an "overwhelming" number of contracts, according to analyst James F. Horan of Bradley Hummel & Co.

The next stage of SDI, which is getting underway on several fronts, will lead to construction and testing of large systems—the projects major aerospace companies see as their ticket to riches. "The real action will go to companies such as Hughes, Boeing, Rockwell, and Martin Marietta," says Merrill Lynch vice president Philip Brannon, a defense-electronics analyst. "As the dollars get bigger, the little study companies don't get the major contracts."

Indeed, the big contracts are starting to kick in. They include:

- The National Test Facility, which will cost $750 million to $1 billion (see "SDI's Biggest Contract," p. 29). The facility will use supercomputers to simulate a nuclear attack, enabling scientists to test how well proposed defense weapons would work. The prime contract for the facility, to be awarded this month, will almost certainly go to either Rockwell International or Martin Marietta, the companies that have conducted most of the research in this area.
- A massive free-electron laser at White Sands Missile Range, N.M., which Boeing and TRW are vying to build. The Army Strategic Defense Command will award the contract—estimated to be worth several hundred million dollars—next summer. Lockheed, the top SDI dollar-getter, will build the laser's optics. The scope of the project means the Department of Defense has apparently made this relatively new technology the focus of its laser efforts—and consequently a key to future contracts.
- An experimental system to shoot down missiles with extremely fast-moving projectiles called kinetic-energy weapons. Rockwell is working on this "space-based interceptor" under a $233-million contract that may be increased to $350 million. The company will build the system during the next four years.
- A space-based surveillance system to detect missiles in the first few minutes after they lift off, when they still have all their warheads. Lockheed Missiles & Space and Grumman Space Systems each have a $304-million contract for research on this system.

There's not much controversy about merely studying missile defense; smaller research companies such as BDM and Titan will be relatively immune to political shifts. But as SDI breaks out of the conceptual research stage, it becomes more susceptible to criticism.

As a result, SDI represents an extremely iffy source of revenue. "There's so much uncertainty about long-range funding that it's difficult to make long-range plans," says Titan's Yonas. "We're not a big company, and we have to be very cautious. We want to define a niche business that will prosper no matter what happens with SDI, so we have lots of ways to win."

Officials at most companies insist that they have not become overly dependent on the program. The more diversified companies, such as Boeing or TRW, count SDI as only a small fraction of their business. However, other contractors appear to have gotten in much more deeply.

THE TOP 20 SDI CONTRACTORS

ORGANIZATION	CONTRACTS AWARDED (millions)
1. Lockheed	$1,024
2. General Motors*	734
3. TRW	567
4. Lawrence Livermore Lab	552
5. McDonnell Douglas	485
6. Boeing	475
7. EG&G	468
8. Los Alamos Lab	458
9. General Electric	420
10. Rockwell International	369
11. MIT	353
12. Raythean	248
13. LTV	227
14. Fluar	198
15. Grumman	193
16. Gencorp	191
17. Honeywell	151
18. Teledyne	189
19. Martin Marietta	134
20. Textron	118

(All figures as of March 1987)

*Through Hughes Aircraft subsidiary

SOURCE: FEDERATION OF AMERICAN SCIENTISTS

THE STAR WARS SURVEY

HIGH TECHNOLOGY BUSINESS conducted a month-long survey of the 318 companies that have received more than $100,000 worth of SDI-related contracts. Questionnaires were mailed to the companies' presidents and were followed by telephone calls to those who did not respond initially.

For many of the 135 survey participants, SDI money represents only a small fraction of their company's total income. Contracts—many of them small—are being awarded to a large number of companies; however, almost half the companies that participated in the survey derive less than 20 percent of their income from SDI work.

Contractors divide evenly on how commercially significant SDI could be. One-third call the spin-off potential high or extremely high, one-third say the potential is low or extremely low, and one-third label the chances "moderate" or did not respond to the question.

Thirty-eight percent of the company presidents surveyed feel an SDI system could be in place by the mid-1990s. But almost as many—36 percent—foresee no deployment in this century, or possibly ever. A solid 40 percent believe that the Star Wars budget will decrease under President Reagan's successor; only 11 percent predict an increase.

Here are the survey results:

■ **What percentage of your annual revenues would you estimate is derived from SDI-related work?**

	Number of respondents	Percent of total
Less than 1 percent	24	17.8%
1—10 percent	40	29.6%
10—20 percent	22	16.3%
20—30 percent	13	9.6%
30—40 percent	6	4.4%
40—50 percent	6	4.4%
50—60 percent	7	5.2%
60—70 percent	2	1.5%
70—80 percent	1	1.0%
More than 80 percent	6	4.4%
No response	8	5.9%

■ **Have you acquired other companies or divisions to increase your SDI capabilities?**

	Number of respondents	Percent of total
Yes	4	3.0%
No	129	95.5%
No response	2	1.5%

■ **Do you plan to do so in the next year?**

	Number of respondents	Percent of total
Yes	7	5.2%
No	116	85.9%
Perhaps	2	1.5%
No response	10	7.4%

■ **How do you rate the potential for commercialization of the SDI-related technology in which you are involved?**

	Number of respondents	Percent of total
Extremely high	24	17.8%
High	21	15.6%
Moderate	31	23.0%
Low	28	20.7%
Extremely Low	17	12.6%
No response	14	10.4%

■ **How much revenue do you receive annually from SDI-related contracts?**

	Number of respondents	Percent of total
$0—$50,000	47	34.8%
$50,000—$100,000	12	8.9%
$100,000—$250,000	14	10.4%
$250,000—$500,000	10	7.4%
$500,000—$1 million	12	8.9%
$1 million—$2 million	9	6.7%
$2 million—$5 million	6	4.4%
$5 million or more	8	5.9%
No response	17	12.6%

NOTE: Percentages may not total 100% because of rounding.

■ **Have you set up a new division or department to deal with SDI-related contracts?**

	Number of respondents	Percent of total
Yes	13	9.6%
No	117	86.7%
No response	5	3.7%

■ **When do you anticipate SDI will be ready for deployment?**

	Number of respondents	Percent of total
1990	19	14.1%
1995	32	23.7%
2000	18	13.3%
Beyond	29	21.5%
Never	3	2.2%
No response	34	25.2%

■ **What do you expect the level of SDI funding to do under the next administration?**

	Number of respondents	Percent of total
Decrease dramatically	21	15.6%
Decrease somewhat	35	25.9%
Remain stable	46	34.1%
Increase somewhat	11	8.1%
Increase dramatically	4	3.0%
No response	18	13.3%

Participating companies

AccSys Technology
Acurex
Advanced Information Decision Systems
Advanced Refractory Technologies
Advanced Research and Applications
Aerodyne Research
Air Products and Chemicals
AKM Associates
Alabama Cryogenic Engineering
Alphatech
American Research
Analytic Decisions
Analytical Systems Engineering
Anamet Laboratories
Ann Arbor Nuclear
Anro Engineering Consultants
Applied Technology Associates
Aptek
Aracor
Astro Innovations
Atlantis Research Group
Austin Research Associates
Automated Sciences Group
BDM International
Bedford Research
Berner Lamphier and Associates
Biospherical Instruments
Boeing
Business and Technology Systems
Center for Remote Sensing
Colsa
Computer Sciences
Control Dynamics
Cordec
Creative Enterprises
CSA Engineering
DCS
Decision Science Applications
Directed Technologies
DWA Composite Specialists
Dynamics Technology
EG&G
EIC Labs
Electromagnetic Sciences
Energy Science Labs
Engineering Analysis
Entech
ETA
Fiber Materials
Flow General
Fluorochem
Foster-Miller
Geltech
GenCorp
General Motors
General System Group
Geonautics
Great Lake Science
GTE
Harold Rosenbaum Associates
Hercules
HTC Industries
IAP Research
IIT Research Institute
Impulse Engineering
Information Science
Information Systems Network
International Software Systems
J.H. Wiggins
Jamieson Science and Engineering
JRS Research
Lambda Physik
L'Garde
Lightwave Electronics
Lockheed
Macula
Martin Marietta
Material Concepts
MEI Associates
Micrel
Mission Research
Mitre
MMR Technology
M&W Microfilm
New Mexico Institute of Mining
Optel
Optra
Orincon
Patel Enterprises
PDA Engineering
Physical Sciences
Plasma Research
Prime Source Associates
Propulsion Dynamics
Quantex
Radiation Monitoring Devices
Rasor Associates
Research Support Instruments
Research Triangle Institute
Riverside Research
SatCon Technology
Schlumberger Ltd.
Schwartz Electro-Optics
Science and Technology Associates
Scientific Systems
Singer
Software Productivity
Space Data
Space Services
Space Tech
Sparta
Spectral Sciences
Spire
SRS Technologies
SSG
S-Systems
SRI International
Surface Optics
Syracuse Research
Systems Dynamics
Talandic Research
Technical Research Associates
Technology Development
Tecolote Research
Tekmat
Tesco
Thermacore
TRW
Vanguard Research
Washington Analytic Services
Xontech
Ztek

THE 6 LEADING TECHNOLOGIES

The six SDI technologies that the Pentagon has chosen to move beyond preliminary research could, if deployed, comprise a complete, though rudimentary, strategic defense system.

Three of the selected programs concentrate on the area known in the Defense Department as SATKA—surveillance, acquisition, tracking, and kill-assessment. These systems would be SDI's eyes and ears; they would detect the launch of enemy missiles, keep track of the missiles and multiple warheads each would release, and determine whether a missile or warhead, once struck, had been disabled. Of the remaining programs, two involve kinetic-energy weapons—"smart rocks"—that would inflict damage by force of impact. The sixth program is a sophisticated network of computers and communications links to manage the whole show. The surveillance and tracking systems would relay their data to these "battle-management" computers, which would, if needed, fire smart rocks at the assaulting forces.

Boost-phase surveillance and tracking
A spacecraft would continuously monitor the earth's surface for signs of a missile launch, relying mainly on infrared sensors to detect the intense burst of heat from a rocket engine. This brief "boost phase" of a missile's flight offers a defense system's best opportunity, because the missile still contains all its warheads, and its flaring rockets are easy to see.

Ground-based surveillance and tracking
After the boost-phase sensors detect a missile launch, the battle-management computers would order the ground-based second layer of surveillance gear into action. A satellite laden with infrared sensors would be launched. By the time the satellite reaches its vantage point high above the earth, the missiles would already have released multiple warheads. Although the warheads would be destined for different targets, they would initially float through space in a cluster. A critical task of the surveillance system will be to differentiate these nuclear bombs from the large number of harmless decoys that will accompany them during this mid-course phase. The decoys would probably be much lighter than the warheads, for example, and would thus move differently. The ground-based surveillance system was formerly known as the long-wavelength infrared probe.

Space-based surveillance and tracking
Sharing the mid-course watch with the ground-based system would be this series of satellites, stationed in space to monitor the swarm of warheads unleashed from a missile. Another important function would be "kill assessment"—ascertaining whether a warhead has been disabled after it has been hit by a laser beam or high-speed projectile. Infrared sensors would look for evidence of a "kill," such as a sudden change in the warhead's trajectory showing that its guidance electronics have been knocked out. This is a crucial piece of information, because it keeps the weapon from wasting its time firing at targets that have already been destroyed.

Space-based interceptor
A fleet of satellites would serve as "garages" for rocket-propelled projectiles. Equipped with infrared sensors and a computerized guidance system, the projectiles would home in on the heat of a missile during its launch or on a warhead during its drift through space. The projectiles would contain no explosives, but inflict damage simply by slamming into the target at extremely high speed.

Exoatmospheric re-entry vehicle interceptor system (ERIS)
Like the space-based interceptor, ERIS would pick off warheads by whacking them with nonexploding projectiles. But ERIS would launch rockets from the ground, aiming at warheads late in the mid-course phase of their trajectory, before they re-enter the atmosphere. For guidance, ERIS rockets would rely on tracking data obtained by the ground-based and space-based surveillance and tracking systems.

Battle management—command, control, and communications
Monitoring and controlling all the pieces of an SDI system would require large computers and extremely complex software. The system would collect information from hundreds of sensors, decide what to do (for example, to fire a laser beam or a barrage of smart rocks), relay the signal to the designated weapons, judge from new sensor readings whether the target has been destroyed, and then revise its tactics as needed. Much work is going into developing electronic circuitry made from gallium arsenide, which is less susceptible to nuclear radiation than silicon, the traditional circuit material. Fiber-optic links might provide resistance to enemy jamming.

Industry observers such as Merrill Lynch's Brannon and the Federation of American Scientists' Pike cite Lockheed Missiles & Space as more SDI-dependent than other big aerospace companies. Lockheed has received more contract money from SDI than anyone else—about $1 billion. Also, Lockheed's bread-and-butter military program, the C-5 aircraft, will soon phase out of production.

The next big contract that could go Lockheed's way is the Advanced Tactical Fighter (ATF), the next-generation fighter aircraft. After a 50-month demonstration phase in 1991, the Air Force will award the prime contract either to Lockheed or Northrop. "If the C-5 goes belly-up and Lockheed loses the ATF contract, Lockheed will be looking at SDI as its only big source of business," says Pike. If SDI should one day shrivel, he says, Lockheed Missiles & Space could "quickly become a much smaller operation."

R.A. Wallner, director of strategic-defense programs at Lockheed, acknowledges that an SDI slowdown would be "noticeable." However, he says, the consequences would not be catastrophic because "SDI contracts represent a relatively small percentage" of the aerospace heavyweight's

$5.3 billion in 1986 defense revenues.

At smaller companies, SDI often accounts for a much higher percentage of business. Companies such as Titan, Flow General, and BDM report getting 10 to 40 percent of their business from SDI. But paradoxically, these companies, which typically have annual revenues of $50 million to $500 million, generally are not as subject to the whims of program planners. Research outfits and software developers can profitably pursue many small contracts that don't require massive investments of time and money. By contrast, Lockheed's decision to bid for the fighter-plane contract means an enormous commitment of resources that will then not be available to seek out other potential business. Another factor also helps shelter small companies: The research they do will be necessary no matter what shape SDI eventually takes.

The aerospace industry sees SDI not just as an open spigot of immediate revenue, but also as a way to attract future defense research-and-development business. Participation in SDI is crucial to a company that wants to establish technological credentials for later contracts. "The biggest reason we're so heavily involved in SDI," says Boeing SDI coordinator Michael Gamble, "is that this is where the new defense technology is happening. We don't want to be left behind."

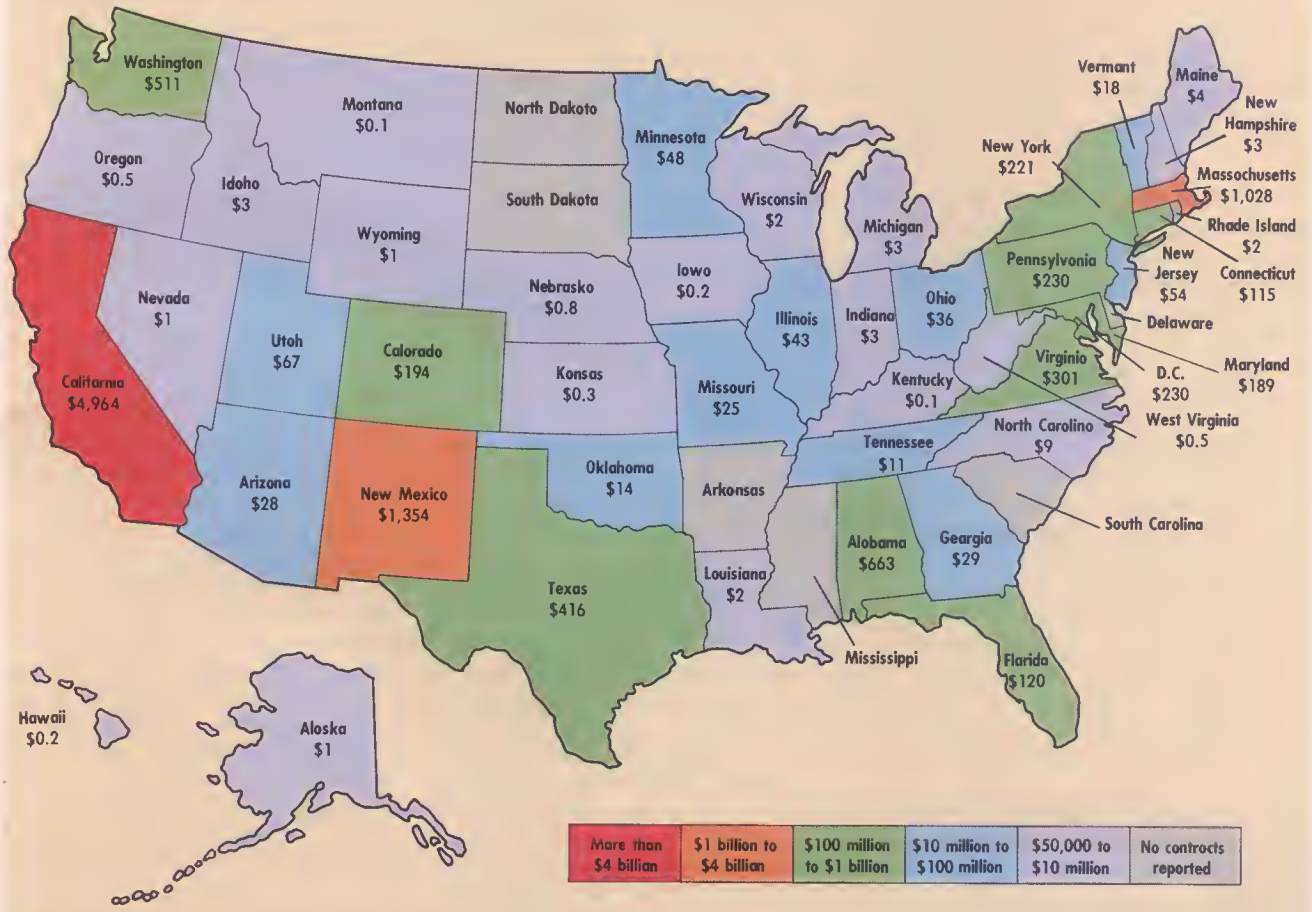
Opportunities may become scarcer, however, now that SDI is narrowing its range of options. Notably absent from the six technologies proposed by the Defense Acquisitions Board for demonstration are the devices most closely identified in the public eye with SDI: lasers and particle-beam generators. None of these "directed-energy" systems is considered mature enough to bring out of the lab.

Instead, the Pentagon has assigned a higher priority to systems that track enemy missiles, and to the computer and communications systems needed for battle management. Among the big players are General Motors' Hughes Aircraft subsidiary, which makes the advanced infrared sensors needed to find and follow flaming rockets.

Other projects selected by the acquisitions board would step up development of "smart rocks"—weapons designed to knock out missiles by the force of impact. These kinetic-energy weapons are being developed under two programs that will now enter the demonstration and validation stage. One program, the exoatmospheric re-entry vehicle interceptor system (ERIS), would launch projectiles from the ground to strike Soviet warheads as they skim the outside of the atmosphere on their journey to the United States. The prime ERIS contractor, Lockheed, is entering the third year of a five-year, $468-million contract.

But Lockheed does not claim a monopoly on kinetic-energy systems. Another program picked by the acquisitions board, the space-based intercep-

SDI REVENUE BY STATE Total contract value in millions, 1983-1987



SOURCE: FEDERATION OF AMERICAN SCIENTISTS

PHILIP A. SCHEUER

THE NEXT STEP: LASERS

Even the most optimistic SDI planners concede that a missile-defense system that uses only the technologies assigned top priority by the Defense Department would let through as many as half the bombs in a full-scale nuclear attack. The next step is to explore more exotic beam weapons—principally high-energy lasers.

This summer, the Army Strategic Defense Command will choose a company to build a free-electron laser for a massive demonstration experiment at White Sands Missile Range in New Mexico. This focuses attention—and funding—on a breed of laser that not long ago was considered the darkest horse in the race; no other laser technology has made it to the stage of such a large-scale test.

Two government/industry partnerships are competing for the contract to build the free-electron laser. TRW's Space and Technology Group in Redondo Beach, Calif., is collaborating with the Lawrence Livermore National Laboratory, and Boeing Aerospace is teamed with Los Alamos National Lab. From a historical standpoint, TRW should have the edge; the company has been active in laser research and development for most of the quarter-century that the devices have been around. Boeing, which did not start major laser work until 1979, has nevertheless established impressive capabilities. Indeed, Boeing has used its own money to build and operate a laboratory specifically to advance free-electron-laser technology. The company also recently demonstrated a laser of this type. No matter which way the decision goes, TRW will be in the game: The company's Defense Systems Group in Redondo Beach has won a $125-million systems-engineering contract, which involves managing the facility and running the experiments.

The decision will not crucially affect either Boeing or TRW. At both companies, only about 5 percent of their defense revenues come from SDI activities. Moreover, both Boeing and TRW are involved in dozens of separate Star Wars projects.

Lockheed, which is not bidding to build the laser itself, may nevertheless walk away with the biggest plum of all: a contract worth an estimated half-a-billion dollars for the optics needed to control the beam. Lockheed will design and build special mirrors to filter out flaws in the raw beam; the beam can then be focused to a more intense point on the target.

A free-electron laser produces intense beams of light by shooting electrons at extremely high speed through a gauntlet of magnets in a vacuum. The magnetic field forces the electrons to follow a serpentine path. The electrons' back-and-forth motion shakes loose photons of light. The electrons are not bound to any atomic nucleus, and hence are "free." (Conventional lasers extract light from energetic atoms or molecules in a solid, liquid, or gas.)

A critical advantage of the free-electron laser is its ability to be adjusted to any wavelength. It would be difficult to defend missiles against such a variable-output laser, proponents say, because many countermeasures guard best only in a particular wavelength range. In addition, this "tunability" makes it practical to keep the laser on the ground, and a ground-based laser would be easier and less expensive to build, operate, and maintain than a space-based laser.

tor, has been the bailiwick of Rockwell International. Rockwell, like Lockheed, needs SDI. Its biggest contract, the B-1 bomber, is winding down, and SDI offers a major source of future revenue.

The interceptor would be launched from rockets stationed in space. Its mission: to knock out Soviet missiles early in a flight, when heat from the rockets makes them relatively easy to track, and before they've released their warheads and decoys.

Because kinetic-energy weapons are much more developed than directed-energy weapons such as lasers and particle beams, the emphasis on kinetic weapons hints that SDI planners may try to construct a working missile shield fairly soon rather than wait until the mid-1990s. As Reagan nears the end of his presidency, there seems to be a push toward getting something built rather than just studying the widest possible range of technologies.

In the last year, high administration officials have publicly advocated accelerating the SDI timetable, to—in the words of Attorney General Edwin Meese—"lock in the program so it cannot be tampered with by future administrations." Defense Secretary Weinberger, too, has urged that a Star Wars system be put in operation earlier than originally planned.

The Defense Department, however, denies any plans to rush a defense system into operation. "Our timetable has not changed. We're still looking at deployment by the mid-90s," says a spokesman at the SDI Organization.

A push for early deployment would mean less money for basic research, but more for big experiments. That's good news for the Rockwells and Martin Mariettas, who have the people and expertise to handle huge projects. But as projects move from lab to demonstration stages, fewer companies can play the game.

Although beam weapons remain strapped into the back seat of the SDI program (they are conspicuously absent from the list of top-priority technologies), they have not been abandoned. Take, for example, the White Sands Missile Range free-electron laser, which will zap beams up through the atmosphere toward targets to test how much damage they inflict (see "The Next Step: Lasers," above).

The choice of a free-electron laser for this demonstration experiment illuminates the uncertainty that lurks at the heart of SDI. At the outset of the program in 1984, the free-electron laser was strictly a laboratory item—and considered a dark horse for strategic-defense work. After many years of development, however, older laser technologies have fallen by the wayside because of assorted shortcomings. Free-electron lasers seem to be winning the laser race by default.

However, the SDI Organization has not ruled out more mature beam-weapon technologies. For example, TRW and Martin Marietta continue to receive funding for so-called chemical lasers, which generate beams of light from re-

acting gases such as hydrogen and fluorine. But severe problems have tripped up developers of chemical lasers. One drawback is that the lasers' infrared beam does not easily penetrate the atmosphere. Therefore, a chemical laser would have to be based in space and could easily be mislead by decoys that would accompany warheads. Infrared light poses a second problem as well; precise focus and aim of the beam would require huge mirrors that would be extremely difficult to produce.

But there's more than one way to zap a missile. In a departure from SDI's mainstream emphasis on technologies that show immediate promise, the Air Force Space Technology Center has awarded McDonnell Douglas a $480,000 contract to build, launch, and test a weapon system based on a beam of hydrogen atoms; the beam will travel at nearly the speed of light. Sometime during the early 1990s, McDonnell Douglas will launch into orbit a suite of satellites that will carry the accelerator, which creates the beam; the practice targets, which emulate warheads; and sensors, which detect how much damage the beam inflicts. The estimated price tag for the whole 80-foot-long apparatus: $750 million.

The companies now feeding happily at the SDI trough have no illusions about the program's permanence. "Defense programs come and go—that's a fact of life in this business," says Gamble of Boeing Aerospace. Most of the companies involved say they will find other markets for the technologies they are developing, even if SDI becomes a program of the past.

SDI will probably spawn more commercial products than the typical military program, according to the program's advocates. "Any time you put this kind of money into developing new technologies, the spin-off value will be significant," says defense-policy analyst Grant Loebs at the Heritage Foundation, a conservative think tank. Titan's Yonas concurs. "SDI encourages innovation and creativity—so spin-offs are more likely than in a mature program, where innovation is the enemy," he says.

The free-electron laser, for example, has intriguing potential as a medical tool. Unlike other lasers, which emit light at only one wavelength or over a narrow range of wavelengths, the free-electron system can operate virtually anywhere in the spectrum. This variability lets the laser cut a variety of tissues and supply light beams to diagnose or treat cancer and other diseases. Indeed, the SDI budget includes about $10 million to advance medical uses for free-electron lasers.

Companies are pursuing commercial potential with other SDI technologies. For example, infrared sensors and computers being developed by Boeing to watch for attacking missiles could aid air-traffic control. Satellite-based sensors could track airplanes flying over the ocean or remote areas beyond the reach of radar, says Boeing's Gamble.

Titan's recently acquired Pulse Sciences subsidiary hopes to develop medical instruments based on equipment that produces huge bursts of electricity. Such pulsed-power technology, which stands at the heart of high-energy lasers and particle-beam generators, could also produce streams of ions that could be used to sterilize hospital supplies. "We talk about making life beams from death beams," says Yonas.

So far, however, little of commercial import has emerged from SDI. The technologies being pursued do not, for the most part, lend themselves to industrial or household use. Moreover, much SDI work is classified, and much of the research that is now open to public discussion will be swathed in secrecy as soon as it produces useful technology.

For most defense contractors, however, the potential of profit-producing spin-offs is a bonus. The real lure of SDI lies in the billions of contract dollars being handed out. And even if President Reagan's successor tries to stem the torrent of money going into SDI, there's little chance that the nascent Star Wars business will dry up.

"It has taken a while for industry to take SDI seriously," says Merrill Lynch analyst Brannon. But with the Star Wars money spigot open wide with little chance of a cut-off, he says, "contractors now have become believers. They see this as more than just some flaky idea." ■

SDI'S BIGGEST CONTRACT

Within two months, the Pentagon will award what may turn out to be the largest contract of the SDI program. The contract will cover a computer center that will help military planners judge the performance of missile-defense systems. The five-year effort will cost $750 million to $1 billion; if the money is awarded in one lump sum, it will be the biggest single SDI contract to date. Even a more gradual outlay will thrust this project into the top ranks of the Star Wars program.

Rockwell International and Martin Marietta are the odds-on favorites of the more than 100 companies that the Air Force Electronic Systems Division asked to submit bids on this center, called the National Test Facility. Last year, these two aerospace giants were given parallel contracts to complete their preliminary concept designs.

The winner of the five-year contract will staff, operate, and maintain the facility, which will use supercomputers to coordinate eight laboratories across the country that are building and testing various lasers, sensors, and other missile-defense devices. This network of labs and projects is called the National Test Bed. In addition, because treaties forbid testing weapons systems in space, computers at the facility will simulate the way the systems work.

Both Rockwell and Martin Marietta have assembled teams of subcontractors who would share the work—and the wealth. For example, Martin Marietta would use Hughes Aircraft for satellite communications links and IBM for information systems, as well as Logicon, Singer-Link, and Nichols Research for simulation software. Martin Marietta would direct these subcontractors toward an exceedingly complex technological goal. The company has solid credentials, having performed such systems integration for the Viking space probe and the advanced air-traffic control system.

Rockwell, which has about twice the annual revenues of Martin Marietta, excels in the design and simulation of large aerospace systems. Its subcontractors are General Electric, Titan, and Ford Aerospace.

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Alternate Fuels Edge Into Auto Markets

Slow but steady progress marks the hunt for better fuels

By Christopher O'Malley

IN THE 1970s, as motorists endured long lines and paid princely sums for gasoline, many hoped the next decade would bring new cars, new fuels, and an end to the oil tyranny of foreign suppliers. But as the 1980s brought only a prolonged oil glut and low prices, the vision faded.

Now alternate-fuel automobiles are coming back into focus. However, the driving force behind this new interest concerns ecology, not economy.

State and city officials across the nation, worried about air-pollution levels, are investigating fuel alternatives. Strict new particle-emission standards from the Environmental Protection Agency are forcing many urban transit authorities to look for low-polluting replacements for diesel power on city buses. Already some cities have begun converting to methane, a clean-burning fuel that can run in slightly modified diesel engines. In another development, electrically powered vans will go on sale to delivery fleets in late 1988.

None of this signals a coming boom for alternate fuels. However, these events represent a significant turning point in what has been a slow and sometimes painful shift away from petroleum-dependent vehicles. At last, some niches are opening for alternate fuels. And proponents maintain that these niches will grow and create more widespread acceptance of new fuels.

"Without a doubt, there's been a fairly dramatic shift to environmental concerns," says Gary Rogers, the president of FEV of America in Southfield, Mich., an independent design and development firm that specializes in engine research.

The general consensus among automotive-industry watchers is that alcohol fuels are the most promising, even though alcohol doesn't yet command even 1 percent of the automotive-energy market. Alcohol burns much more cleanly than gasoline. Blended in small quantities with gas, alcohol can increase the amount of oxygen in the fuel so engines produce fewer pollutants. Burned alone, alcohol can cut emissions radically. Further, conventional automobile engines need only slight modification to use alcohol fuels.

Gasohol, a mix of 90 percent gas and 10 percent ethanol (grain alcohol), works in unmodified automobile engines. Sold in several midwestern states since the early 1980s and seemingly abandoned when gas prices began to fall, gasohol is on the upswing, notes Frederick L. Potter, president of Information Resources, a market researcher. In 1981, 1.5 percent of all gasoline sold in the United States contained ethanol; this year, that figure may reach 9 percent. Potter sees only soft growth for the next five years, barring significant legislation from the federal government or larger states.

Such legislation may indeed be in the offing. Colorado will soon require motorists in larger cities to use only gasohol during the smog-ridden winter months. Several other states and cities, including Phoenix and Los Angeles, are considering similar measures. Major ethanol producers such as Archer-Daniels-Midland of Decatur, Ill., are lobbying hard for this type of legislation.

But even with more widespread use

ELECTRIC CARS MAKE SPARKS

In the U.S. auto industry's own backyard, Detroit Edison has carved out a pioneering role in developing and promoting electric cars. Now the company's commitment to battery-powered vehicles is at last about to pay off. By this time next year, Detroit Edison should be leasing electric vans to small fleets in and around Detroit.

Detroit Edison got serious about electric cars in 1980, when it signed on as a demonstration site for the Department of Energy. The utility removed the back seats from 24 Volkswagen Rabbits to make room for batteries. "The purpose was to evaluate the viability of these cars in real-life use," explains Gerald Nicholas, director of product marketing for Detroit Edison. Employees used the modified Rabbits as second cars.

Nicholas claims the program was successful because the cars performed reliably. But even before the experiment ended last July, market research by Detroit Edison and the University of Michigan indicated that consumers are not interested in cars that can travel only 50 miles before they must head for an outlet to recharge.

KIM KAUFFMAN

Detroit Edison's Nicholas sees profit in electric cars.

Yet the same research found that trucks in the delivery fleets that abound in every city rarely stray more than 50 miles a day. Detroit Edison eyed a new market. In September 1985, the utility bought six electric trucks from the English vehicle maker Bedford, a division of General Motors. After six months in its own fleet, Edison loaned the trucks to commercial fleets for evaluation.

Response was enthusiastic enough to convince the utility to buy more electric trucks to lease to its customers. But before it could, GM shut down Bedford. "We were in limbo," recalls Edison's Nicholas.

Now the plan has been revitalized, as Detroit Edison waits for a new line of GM electric vans expected to be produced late next year. "There's a great deal of interest," says an enthusiastic Nicholas, who expects to have no difficulty leasing the 200 electric vans Detroit Edison will initially purchase.

of gasohol, the longer-term potential for ethanol isn't bright. It is made from grain, and suppliers would not be able to make enough to significantly displace gasoline.

Methanol, sometimes referred to as wood alcohol, shows much more promise. Currently the supply of methanol is too limited for widespread automotive use; a spokesman for Dallas-based Celanese, a leading methanol producer, says current U.S. production could not replace even 10 percent of the gasoline sold. However, the main source of methanol, natural gas, is plentiful. Coal, which is abundant in the United States, also can be converted to methanol, though no plants have yet been built. Nevertheless, short supply shouldn't be a problem if, as current trends indicate is probable, the introduction of methanol-burning vehicles continues at its current slow pace.

The first push for methanol burners may come from city buses. After the EPA emission standard goes into effect in 1991, virtually all of the 2,500 to 4,000 new buses purchased annually by U.S. cities will burn methanol, predicts Jeff Sylvester, manager of on-highway marketing for Detroit Diesel Allison, a General Motors division that offers methanol-powered diesels. Transit programs in three U.S. cities already use a few methanol-powered buses.

Methanol's best chance to enter passenger-car markets will come after local clean-air legislation opens a door. California leads the way; its state-owned fleet of 700 Ford Escorts runs on methanol. The state also recently invested $5 million in a program to reduce smog by using methanol. Much of the money will help create a methanol test center and buy new flexible-fuel vehicles from Ford, GM, and Chrysler. Flexible-fuel vehicles use sensors to automatically adjust engine performance for gasoline, methanol, or any combination of the two, permitting cars to use both fuels simultaneously.

Such initiatives at state and local levels are giving methanol a toehold in the market. Once the fuel gets into such

WHAT THE BIG 3 ARE DOING

Whether powered by methanol or electricity, most alternate-fuel vehicles probably will come from familiar sources: General Motors, Ford, and Chrysler, plus major Japanese and European car makers. Research and development on new fuels and vehicles by the Big Three automakers has been renewed in earnest, prompted in part by mandatory air-quality standards from the Environmental Protection Agency.

The focus at the Big Three, as at other car manufacturers, is mainly on alcohol fuels, particularly methanol. The companies are concentrating on two basic approaches. The first is dedicated methanol engines; the second involves flexible-fuel vehicles that run on varying mixtures of gasoline and alcohol.

The dedicated engines are essentially the same internal-combustion engines that burn gasoline, altered for oxygen-rich but corrosive methanol. The flexible-fuel approach is not as simple but seems more promising, at least until the distribution of methanol becomes more widespread. A flexible-fuel vehicle has an electronic sensor that gauges the proportion of gasoline and alcohol in the fuel tank. A computer automatically adjusts engine settings to compensate for the fuel mix.

Currently, Big Three production of methanol vehicles is limited to an occasional order by states such as California, which use them in small fleets of cars or vans. Adapting the vehicles requires little more than modifying the fuel-delivery system and using materials that do not corrode when exposed to alcohol.

Electric vehicles are a lower priority. Research continues, however, and each of the Big Three has been active in converting its present lineup of small vans to electric power.

Despite recent advances in battery technology, automakers recognize the historic appeal of the internal-combustion engine. "Unless we run out of gasoline or alcohol fuels, most people are going to want the range and rapid refueling of combustion engines," says Brad Bates, manager of the electric transaxle project at Ford. An electric car may be ideal for the daily commute to work, he says, "but it doesn't cut it on Saturdays when you want to go to grandma's."

niches, it may prove itself to drivers by its performance. Methanol burns at a higher compression ratio, so engines designed for methanol run better than gasoline engines do. Also, converting a gas engine to burn methanol "is not nearly as difficult as some would lead you to believe," says Roberta Nichols, supervisor of alternate-fuel development at Ford. "It's the same basic engine."

Thus, methanol may carve a sizeable slice out of the gasoline market even before the next decade ends, predicts Ray Lewis, worldwide manager for methyl fuels at Celanese. He foresees methanol use "on a par with unleaded gas within 20 years," and maybe sooner should gas prices once again soar.

If methanol succeeds, the chemical companies that produce it—Celanese is the largest—will certainly benefit. But Lewis points out that the oil companies own many natural-gas reserves, and they control fuel stations. Therefore, they will most likely remain dominant players in the fuel industry even as the methanol market unfolds.

As with methanol, electric vehicles are also finding their way into market niches. "We are right on the brink of making it happen," says Jerry Mader, president of Electric Vehicle Development, a nonprofit market-development firm funded by a consortium of electric-utility companies.

Thanks to Electric Vehicle's efforts, electric vans for small fleets used by such businesses as florists or laundries will be available by late 1988. In August, General Motors will begin shipping vans to the customizing plant of Cars & Concepts in Brighton, Mich., which will outfit them with electric drivetrains and battery packs supplied by Chloride Silent Power of Birmingham, England. The vans will be able to travel about 50 miles a day before recharging, a range that is too limited for most consumers but meets the needs of many local fleets. In addition, maintenance can be a significant expense for fleets, and electric cars and vans require less maintenance than gas- and diesel-powered ones.

The battery pack's $4,000 cost could hurt sales. However, the cost to recharge a battery is about half that of an equivalent amount of gasoline, points out Gerald Nicholas, director of product marketing for Detroit Edison, which supplies electricity in southeastern Michigan. Amortized over the life of a vehicle, battery and electricity costs compete handily with fuel, he says.

Detroit Edison plans to buy about 200 electric vans and lease them to fleets in its service area. In southeastern Michigan alone, says Nicholas, there are about 50,000 fleet vehicles that run less than 50 miles a day. Nationally, about 1.7 million such vehicles are used.

That market should expand in 1989 or 1990, when new high-temperature sodium-sulfur batteries from Chloride Silent Power and Toronto's Powerplex Technologies extend the range of electric vehicles to about 100 miles.

Electric cars for the masses are probably further away. Nevertheless, success with urban fleets might plant the seeds for an electric passenger-car market, says Gary Purcell, who heads electric-vehicle development at the Electric Power Research Institute (EPRI) in Palo Alto, Calif. "If we do the job right with commercial vehicles," he says, "the passenger-vehicle market will follow." Electric passenger cars for urban use probably will follow within a decade of widespread fleet introductions, he predicts.

Peter Bos, a former program director at EPRI and the president of Polydyne, a market-research firm, foresees electric vehicles gaining only 1 percent of the overall automotive market by the year 2005.

By the standards of 1979, when alternate fuels were still a shining hope, this decade's progress toward electric cars and alcohol fuels may appear painfully slow. But people familiar with energy issues don't rule out the chance that things may again heat up. Says Ford electric-vehicle researcher Brad Bates, "If you start getting lines at the gas station again, all bets are off." ■

Christopher O'Malley is a free-lance writer who specializes in electronics and other technologies.

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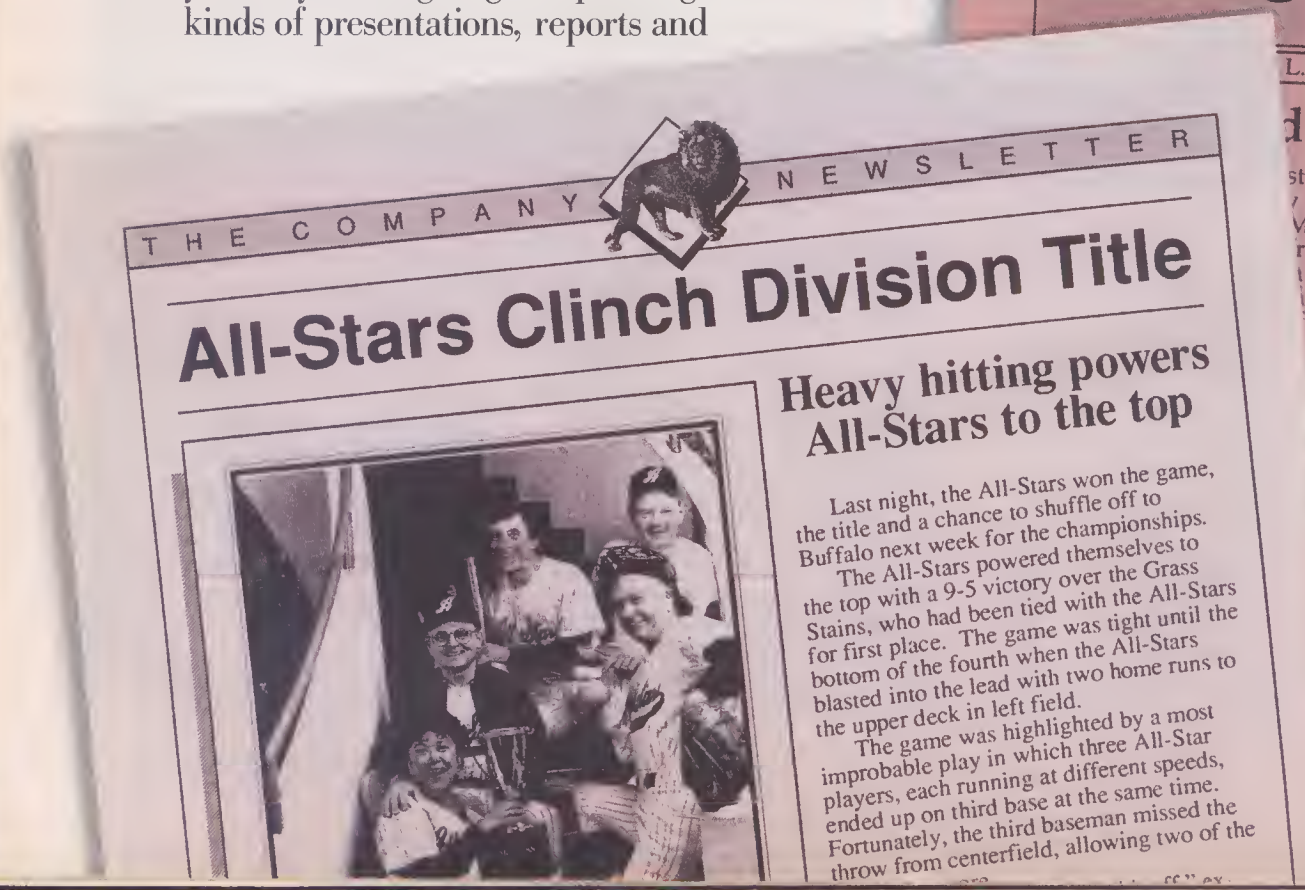

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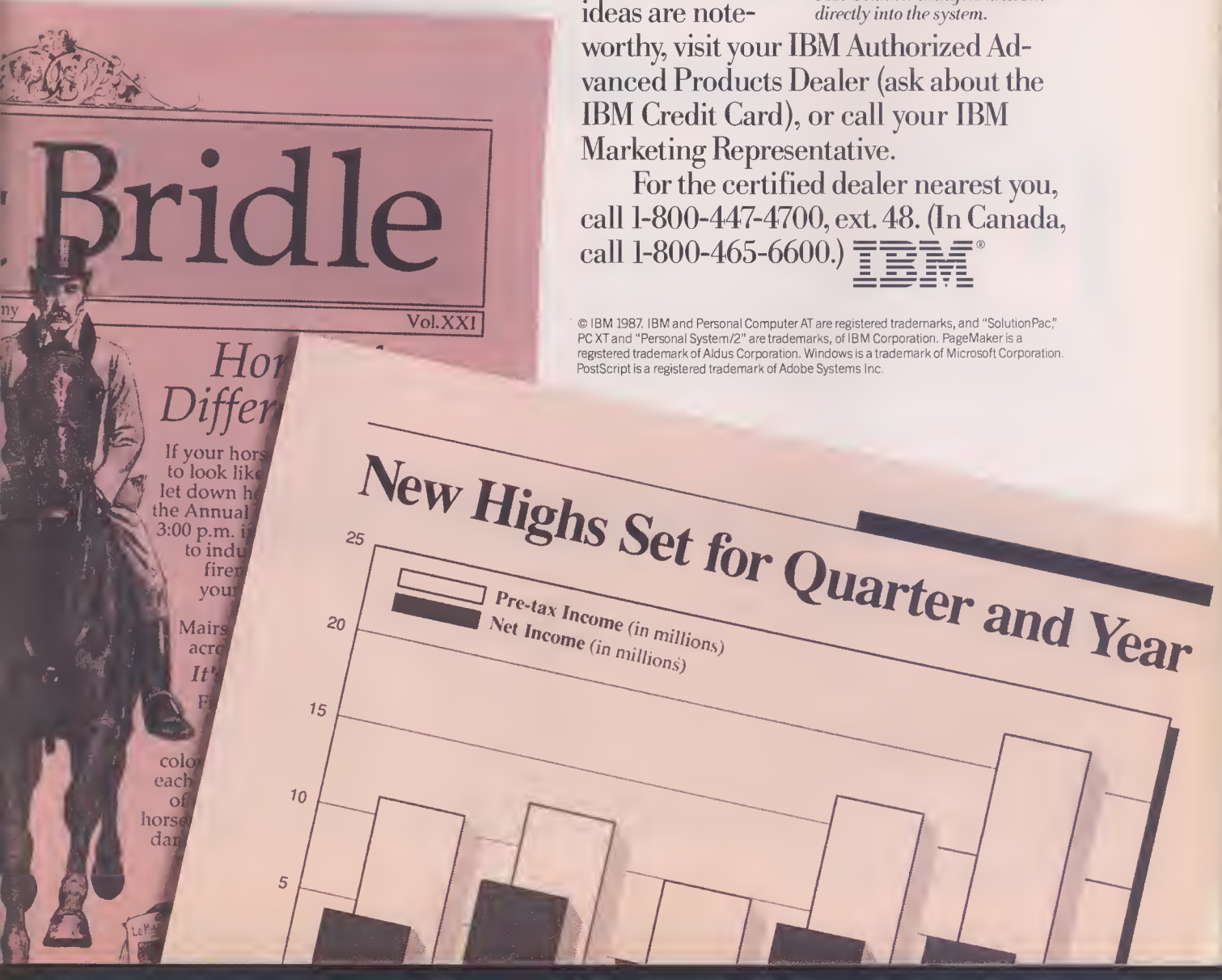

Companies Turn Old Ideas Into Profits

Businesses are seeking novel ways to share innovations—and profits—internally

BY AL SENIA

FROM ITS corporate offices in Beverly Hills, Calif., Litton Industries sits atop a wildly diversified high-tech empire that encompasses more than 50 operating divisions around the globe. Litton manufactures everything from naval ships to metal-cutting machines to equipment used to find oil. With so much going on in so many places, one would think that Litton must be a conglomerate of divisions too diverse to go anywhere but their separate ways.

But officials at the $4.5-billion company are closer than one might suspect, thanks to a corporate policy that encourages the spread of ideas and innovations from one division to another. When Litton's Guidance and Control Systems Division developed a line of highly successful inertial navigation systems for jet fighters, it didn't just sit back and watch the profits roll in. The division hustled some experts over to another Litton group serving the commercial aerospace sector. That group adapted the guidance technology for civilian aircraft; the result has grown into a $200-million annual business.

Litton is one of a growing number of U.S. manufacturers who are discovering that new, money-making technologies often are best found in their own corporate backyards. By grafting technological capabilities from one division onto the products of another—or even creating a new business group around a product or process—companies are getting a much bigger bang from developments that otherwise might remain isolated in a single, limited market.

This concept, called technology transfer, is not new. Typically it is used by large, multifaceted companies that serve both military and commercial markets. Because modern military technology usually requires large research investments in products for which demand is often relatively low, technology traditionally flows from a company's military division to its commercial sector, which revises it to meet the needs of commercial markets.

Ever-increasing competitive pressures are making many U.S. companies much more aggressive in targeting key processes or products and providing the support necessary to spin off commercial successes.

"Technology transfer is certainly becoming more common within U.S. companies," observes Peter S. Glazer, vice president of advanced technology for consultant Arthur D. Little. "They've seen, for example, how successful Japanese companies have been at it."

Companies that have profited most from such exchanges generally foster cross-fertilization in two ways. First, they set up a corporate culture that encourages open communication among divisions. Second, they establish networks that provide a formal way for divisions to exchange technology.

The change to a more open corporate culture may be the more difficult of the two tactics, because it requires a

DEVIS GREBU

change in attitudes that have become entrenched. Unlike their Japanese counterparts, many U.S. companies have found it productive to pit divisions against one another. Progressive managers are realizing that this practice does not promote the exchange of ideas. "The successful companies have opened up communications much more," says Glazer.

One way to promote such a culture is to show employees that the company is committed to cross-fertilization. For example, TRW, through its Technology Transfer Awards Program, bestows gold, silver, and bronze medals as well as cash grants from $2,500 to $10,000 for projects that improve profitability, productivity, or product quality.

A technology-transfer network, because it is more tangible, is easier to institute and manage than employee attitudes. TRW recently established a computerized technology index that lists key personnel and their technological capabilities. This index tells company engineers and researchers what technological resources are available within TRW, and—important in a company of 86,000 employees—where to find the experts.

Texas Instruments, which also is recognized as an industry leader in technology transfer, has linked senior technical managers and engineers from its half-dozen business groups in its Corpo-

A TRANSFER WHOSE TIME NEVER CAME

Sometimes even the best technology may not succeed in a new market. TRW discovered this in 1985, when cable-television companies rejected its newly developed technique for scrambling TV signals.

The television venture started out as a textbook example of technology transfer. TRW researchers had developed a way to scramble and unscramble digital data signals for the military, ensuring secure transmission of sensitive information. Then came the nascent cable-TV business, looking for a way to disguise its broadcasts to prevent them from being captured by airwave pirates. TRW's scrambling technique seemed like a perfect fit. In 1983 the company set up a new business group to transfer the technology.

In little more than a year, the transfer was complete. TRW stormed cable companies with its specially adapted scrambling technique. But it met defeat. Cable companies were already adopting "a more immediate technology that was less sophisticated than TRW's, but still acceptable," recalls TRW vice president Arden L. Bement, whose duties include overseeing the spread of technology within the company.

The product was abandoned about a year later, and TRW officials will not disclose the amount of investment lost on the project. ■

rate Engineering Council. Further, the company singles out technologies for transfer to new areas, assigning a team of experts to move the process along. Current targets include a program to move static random-access memory (SRAM) chips from the company's semiconductor division to its defense electronics group. Another team will develop commercial gallium-arsenide microchips for the semiconductor group, based on expertise acquired in the company's defense group.

Texas Instruments' network operates on other levels as well. The company publishes a technical journal six times a year for its employees. Each division has a technical coordinator, who serves as a gateway through which outside developments may enter. Also, the top 500 company researchers prepare "interest profiles" for a computer database, much like TRW's technology index. "Employees are expected to make their information available to their colleagues as appropriate," says Michael Lockard, chairman of the Corporate Engineering Council.

None of this appears stupendously innovative, Lockard concedes. But taken together, he says, it makes a big difference.

At other companies, the right formula has yet to surface. Even though the concept sounds simple, successful transfer of technology isn't necessarily easy, as General Motors, among others, has learned.

The automotive giant has been sitting on a treasure trove of innovation since its 1985 purchase of California-based Hughes Aircraft, a defense company heavily oriented toward research and development. Although some analysts warned from the start that widely diverse corporate cultures could pose problems, the Hughes acquisition was generally expected to set the stage for major technology transfers between the aerospace and automotive sectors. GM chairman Roger Smith pledged that Hughes would help the automaker remain competitive by applying "its expertise to GM's manufacturing needs at our 152 plants nationwide." He also predicted that the Hughes association would redefine "the basic car or truck from a mechanical product that includes a few electrical subsystems to one with major electromechanical and electronic elements."

Such advances have yet to materialize. Both GM and Hughes have been bogged down by quality concerns and competitive battles in their respective industries. As predicted, the two corporate cultures have been difficult to mesh. Critics also contend that technology transfer at GM is not the high priority it has been at other companies, such as Texas Instruments or TRW. It certainly has not been made as highly visible to employees, they say.

Nevertheless, Mounir M. Kamal, technical director of mechanical, electrical, and electronic engineering for GM Research Labs, still has high expectations for the Hughes/GM association. Within one to three years, he says, Hughes' expertise in missile-control sensors will probably be put to work in producing advanced anti-skid braking systems for cars. Similar sensor technology is expected to make its way from Hughes into GM shock absorbers and other components that will control a car's movement for better comfort and handling. Technological expertise may flow in the other direction as well; advanced structural techniques to control noise in GM cars may soon be applied to aircraft.

One thing the company has learned about transfers is the need for patience. "Success is not a simple occurrence," says Kamal. "What a research lab may produce and what a customer needs is often not the right item at the first crack. Success really depends upon the ability of the researcher to look at the market and redesign, reiterate, and reform the product."

Patience and determination were behind one of the most successful technology transfers at TRW, which resulted in the RedaRed oil-well electric cable made by the company's Lawrence Cable division. The product evolved from efforts to halt cable corrosion in deep oil wells, where high temperatures and chemicals destroyed the rubber jacket on wires in the company's submergible oil pumps.

TRW's Electronics and Defense Sector had already begun researching synthetic rubber for missiles, tanks, and airplanes. Jon Martin, the sector's expert in rubber technology, took on the oil project in 1975. He visited oil fields, ran lab experiments, and developed a solution: jacket the oil cables with a rubber compound called EPDM.

Oil-industry experts debunked the solution, claiming that, under high tem-

FIVE TECHNOLOGIES RIPE FOR THE PICKING

COMPANY	TECHNOLOGY	DIVISIONS INVOLVED	NEW USE	TIME FRAME
Boeing Box 3707 Seattle, WA 98124 (206) 655-2121	Pressure sensors for on aircraft fuel-metering system that eliminates wires in tanks	Boeing Electronics developing for possible use by three Boeing companies: Commercial and Military Airplane, and Aerospace	In civilian or military aircraft, to improve precision and reduce maintenance	1990 or 1991
General Motors 3044 W. Grand Blvd. Detroit, MI 48202 (313) 556-5000	A head-up cockpit display that projects information onto the windshield of a jet fighter	Hughes Aircraft transferring to GM automotive operations	Dashboard-instrument readings projected on car windshields	1992
Litton 360 N. Crescent Dr. Beverly Hills, CA 90210 (213) 859-5000	Fiber-optic components for electronic systems	Polyscientific Division transferring to Guidance and Control Systems Division	Lighter, more accurate gyroscopes for inertial navigation systems	1990s
Texas Instruments Box 655474 Dallas, TX 75222 (214) 995-2011	Gallium-arsenide microchips for processing microwave signals in military products	Government Electronics transferring to Commercial Semiconductor Division	Microwave gallium-arsenide chips for commercial products	Imminent
TRW 1900 Richmond Rd. Cleveland, OH 44124 (216) 291-7000	Microwave radar on missiles to detect approaching projectiles	Defense Electronics transferring to Car and Truck operation	Collision-warning radar for heavy-duty trucks	1990s

peratures, a cable treated with EPDM would swell and burst its protective armor. Resistance was so strong that no company would agree to test the material in a well.

So Martin devised his own test, using pressure vessels that simulated conditions in an oil well. Not only did EPDM succeed, but RedaRed cables have become the industry standard. "They have gained the major share of the oil-well cable market," says Arden L. Bement, the TRW vice president who oversees innovation exchanges.

Despite difficulties, technology transfers continue to yield highly profitable new businesses or even new divisions. For example, recent cross-fertilizations at TRW include the development of a commercial business in large-scale integrated circuits. The electronic systems group originally developed the technology for use in defense-industry signal-processing. "Now we're selling to both commercial and government markets," says Bement. "The entire business was spawned from a technology transfer from one group. Now it's a self-standing company division."

Technology for Texas Instruments' digital signal processors, first developed to meet stringent military specifications in the military-products group, was transferred to the semiconductor group, where it yielded a successful commercial line. Though related, the military and commercial products differ in their operating temperature ranges, voltage requirements, and packaging.

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Despite difficulties, technology transfers continue to yield highly profitable new businesses or even new divisions.

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"The successful transfer required a tightly coupled organization," explains Robert Veal, Texas Instruments' manager of military components. "There had to be close cooperation between the design people, the commercial business, and the military group that initially developed the product."

For companies that have experienced the payoffs of technology transfer, such close cooperation is becoming standard business practice. For example, Litton's Guidance and Control Systems Division—which passed its inertial navigation system to a commercial products division—is now getting assistance from another Litton sibling. Fiber-optics expertise on loan from the polyscientific division is being harnessed to create the next-generation gyroscope, which is expected to weigh less and be more accurate than the laser-based gyroscopes now in use. Because these new gyroscopes are part of the inertial navigation system sold to the military, they will probably make their way to the company's commercial navigation business as well.

This may be a glorified version of hanging around the office water cooler, but companies that promote such communication among departments are finding it pays off in new profits. ■

Al Senia is a freelance writer who specializes in the aerospace industry, science, and technology.

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The Return of Outside Data Processing

Service companies turn to new applications in vertical markets for growth

BY HENRY FERSKO-WEISS

WHEN ADP Inc. began processing information on car crashes for automobile insurers in 1980, appealing to a specific industry was an anomaly for the data-processing company. In business since 1949, ADP had grown fat offering generic payroll-processing and computer-timesharing services to companies from airlines to broadcasters.

But the success of the auto-collision service—ADP now helps insurers settle five million claims a year—led the company into specialized products for other industries. Soon, ADP customized its interactive accounting service into special products for manufacturers and distributors. ADP also became the largest non-bank provider of automated-teller-machine network services, tying together 35 regional networks and executing seven million transactions per month. And brokerage services, bolstered by a 1983 purchase of GTE's stock-quote and front-office brokerage services, now account for 25 percent of ADP's revenues.

All told, vertical market segments represent 55 percent of the $1.4-billion company's business, with payroll processing contributing most of the rest.

Like ADP, many service bureaus that handle the information needs of other companies are changing direction. Data-processing companies once offered all-purpose services covering such functions as payroll, planning and analysis, and general-ledger accounting for almost any kind of business. However, as information needs become more complex, many companies in this $20-billion industry are finding it more profitable to target individual markets.

The push into vertical markets represents a dramatic shift from the early days of the data-processing industry, when service bureaus focused their efforts on basic cross-industry applications. As computer costs fell, more and more companies computerized basic business functions without relying on service bureaus.

But instead of giving up, third-party data processors discovered that their investment in computing power and applications-software expertise could attract a different kind of business. Payroll processing still makes up the largest single application, but by creating powerful vertical market applications, outside data processors again have

THE BIGGEST MARKETS

MARKET	1986 REVENUE	1987 ESTIMATED GROWTH
Banking	$3.7 billion	15%
Medical	$1.1 billion	18%
Process manufacturing	$793 million	16%
Insurance	$696 million	21%
Discrete manufacturing	$672 million	21%
Telecommunications	$414 million	22%

SOURCE: INPUT

THE TOP 5 DATA PROCESSORS

COMPANY	ADDRESS	1987 REVENUES
Electronic Data Systems	7171 Forest Lane Dallas, TX 75230 (214) 661-6000	$1.5 billion
Automatic Data Processing	1 ADP Blvd. Roseland, NJ 07068 (201) 994-5000	$1.4 billion
Shared Medical	650 Pork Ave. Malvern, PA 19406 (215) 296-6300	$385 million*
MTech	1712 Commerce St. Dallas, TX 75222 (214) 742-7100	$230 million*
Systematics	40001 Rodney Parham Rd. Little Rock, AR 72212 (501) 223-5100	$142 million

All figures for fiscal 1987 *Estimate

Apart from the independents, several diversified companies have stakes in the field that would place them among the leaders, including Control Data, Equifax, GEISCO (owned by General Electric), Martin Marietta Data Services, and McDonnell Douglas. As divisions of larger companies, they do not report directly on the size of their data-processing operations.

SOURCE: ALEX BROWN & SONS

something to offer that customers can't do themselves.

Insurance companies, medical institutions, and manufacturers are increasingly looking outside their own walls for specialty computing needs. However, the most dramatic move has been in the banking industry. Unable to cope with increased demand for new financial services that depend on computerization, more and bigger banks are abandoning their in-house data-processing operations entirely and turning back to third-party processors.

"Because banks have always been on the cutting edge of technology, this movement to outside data processors may be the first sign of a trend that will sweep through other industries," says Mike Cohn, a program manager at Input, a market-research company in Mountain View, Calif.

For example, he says, insurance shows signs of being the next industry to shift data processing out of house. Traditionally, large insurance companies have done their own data processing; smaller companies used services such as Policy Management Systems in Columbia, S.C., and Equifax Services in Atlanta. But traditions are changing.

"The demand for information and data-processing resources has become so great that it's no longer cost-effective to keep enlarging the in-house data-processing staff," says Steve Lipsky, product manager for Equifax Services, which concentrates on the insurance industry. "They are coming to companies like ours for special needs."

Equifax is now developing a product that combines aspects of outside data processing and database access. Its new CLUE (Comprehensive Loss Underwriting Exchange) service compiles claims data from the 27 insurance companies that subscribe to the service to supplement state motor-vehicle reports. Tested in Illinois, the initial program covers passenger cars, but CLUE will be expanded next year to cover homeowners and commercial-automobile policies. Equifax plans to add commercial property in 1989.

"The value is in the underwriting process. Motor-vehicle reports—the primary third-party information source for evaluating insurance applications—can be very inaccurate," Lipsky says. Also, many kinds of claims never show up on the reports. CLUE provides insurance companies with a more complete picture of an applicant's claims activity, so the company can make sure the person pays the appropriate premium for the level of risk involved. "This service is a way of bringing it all together," he says.

The medical industry, too, is showing signs of moving toward data-processing service companies for some applications, pushed by the growing trend of computerization in the health field. Scott Holmes, vice president of Shared Medical Systems in Malvern, Pa., believes hospitals will once again turn to outside companies for most of their data processing.

"Outside data processing is certainly a less expensive applications solution," Holmes says. "When hospitals become more cost conscious, I think they will return to the service-bureau approach, but they will have to get burned first."

Hospitals are already hitting the cost wall and have started a binge of downsizing and other cost-containment exercises. Input's Cohn says the use of outside data processing by the medical industry is increasing at an annual rate of 18 percent, making it one of the fastest growing market segments. "As in the insurance business, hospitals are turning to data processors for individual applications—the ones that are too costly or too cumbersome to maintain internally," Cohn says.

But the change will come hard. The traditional hospital fascination with equipment and technical gadgets has led many larger hospitals away from outside data processing. Therefore,

HOW OUTSIDE DATA PROCESSING WORKS

The arrangements between third-party data processors and clients vary from running a computer department at the customer's site to linking the customer via satellite to a data center thousands of miles away.

In a sense, remote data centers are like power plants; they generate services as a utility would generate electricity. To do this, they use an incredible array of mainframes and minicomputers, high-capacity disk drives, printing devices, terminals, and high-speed modems. For example, FIserv has 450 customers and communicates almost constantly with 16,000 terminals. Some of the equipment is expensive and beyond the means of many medium to large companies. For example, MTech owns two of IBM's 3090 Sierra mainframes, which cost $7 million each.

Typically, the service company owns and operates the processing equipment at its remote center. But service companies sometimes operate equipment on the customer's premises, using their own personnel and software. Depending on the arrangement, the computer equipment at the site might be owned by either the customer or the data proces-

DAVID WAGENAAR

FIserv chairman George Dalton says hidden costs help tilt the balance toward outside data processors.

third-party companies such as Shared Medical are shifting their product offerings to hospital software applications they can sell or lease, and to professional services. "There are only two medical data processors who still maintain data centers and do traditional service-bureau business: McDonnell Douglas and us," says Holmes. Shared Medical's service-bureau operations, once the mainstay of the company, now account for less than 50 percent of revenue.

However, Holmes says there has been an increase recently in hospitals turning to Shared Medical for financial applications. "They see it as a necessary evil, so they look to somebody else to do it for them," says Holmes.

Banks are going still further, abandoning their once-prized in-house data-processing departments for outside firms. This trend has made data processors that specialize in banking some of the hottest companies in the business.

This year alone, banks will pour $3 billion to $4.5 billion into the coffers of third-party data processors. Input estimates that, by the end of 1990, the market will reach $7.5 billion. Much of this 18 percent annual growth will come from a shift by big banks to outside data processors. According to *Bank Network News,* an industry newsletter, about 100 of the nation's 500 banks with more than $1 billion in assets have decided to junk in-house departments and rely completely on outside companies—and the trend is accelerating.

For example, 18 months ago, MTech, sor. Such arrangements, called facilities management, help hold down costs because the service company enjoys important economies of scale compared to the client company, even though it must create a separate computer center. Data-processing companies can qualify for volume discounts and spread their research-and-development costs over a larger customer base.

Most facilities-management operations involve installing new equipment and systems. Systematics and General Motors subsidiary Electronic Data Services have invested heavily in these types of operations.

The banking industry, the biggest and hottest segment of the outside data-processing market, illustrates the industry's general principles. In the most traditional approach, a customer sends all data by courier to a data center at the end of the day. The service bureau manually enters the information into its computer system, then processes the day's information.

Banks with less than $100 million in assets generally use this batch-processing approach. A more sophisticated approach to basic service enters the daily work electronically with proving machines manufactured by such companies as IBM and NCR. Dedicated telephone lines and modems link the machines to the data-processing company's remote data center. The customer receives the processed information the next morning, either electronically or via courier.

THE HOTTEST MARKET

The financial industry represents the hottest market for outside data processors, but every bank has its own reasons for making the switch. Economics is key, but deregulation, consolidation, and new technology also play a role.

The economics alone can be persuasive. Outside data processors can save billion-dollar banks a healthy chunk of the $100,000 to $500,000 a month they spend on in-house data-processing operations. "We have been able to save banks about a third of their expenditures on processing and provide them with the same or better service," says George Dalton, chairman of FIserv. "For example, in early 1986 we brought in First Savings, a large Wisconsin savings and loan that had a $3-million computer budget. We are now charging them $1.2 million a year."

ROCKY THIES

Great American's Rod Tompkins rejected "home-grown" software.

The savings can be surprising. Last July, for example, National Bankshares Corp. of Texas, in San Antonio, abandoned 25 years of internal computer operation to sign with FIserv rival MTech. "We will save about $1 million a year for the five years of the contract," says Richard Calvert, chairman of National Bankshares. "We didn't expect such impressive savings."

Bank deregulation helped prompt the move. National Bankshares is converting to a branch banking system because of a change in Texas banking law. The $3-billion holding company's 25 banks will become 12 banks with branch offices. "The conversion would have taken much longer if we had done it ourselves in-house," says Calvert.

Technology was the impetus for Great American First Savings Bank, a $14-billion bank in San Diego, to turn to Systematics."Five years ago, when we went to Systematics, we were spending virtually 80 percent of our programming hours on fixing problems as opposed to putting in enhancements and new programs," says Rod Tompkins, Great American's executive vice president and operation group manager. Most of the problems were caused by 13 years of implementing "home-grown" software, as Tompkins refers to it. "We just couldn't cope with the costs and the difficulties of messy conversions and upgrades."

As a measure of the before-and-after difference, Tompkins reports that in 1982 his bank had assets of $4 billion and employed 80 programmers. Today, the bank is more than three times as large but needs just 60 programmers. It would need even fewer had it not decided to retain ownership of the hardware.

Advanced service-bureau technology can help clients make money as well as cut costs. Relational databases, for example, let bankers dynamically rearrange customer information in any way they want. By linking together data in new ways, bankers can analyze such factors as net balance levels in customers' accounts or family size to see which customers are likely to buy certificates of deposit and when. Banks can search the databases to target customers for special sales pitches.

The revenue opportunities offered by relational databases make them attractive to many banks. But Linda O'Keefe, an analyst at Dataquest, a market-research firm, warns that banks may find it extremely difficult to implement these techniques themselves. "They have to be built right into the DDA [demand-deposit accounting] and TDA [time-deposit accounting] parts of the system," she says. "This is difficult because it is the very guts of the bank's data processing, and these systems may have been written 15 to 20 years ago."

the largest independent data processor in the banking market, listed only one customer with assets of more than $1 billion. Today it has 12, and many are worth more than $3 billion each. Systematics, another third-party data processor, has about 54 big bank clients. Although some of these clients signed on in the 1970s, Systematics gained about a quarter of them just last year.

"The impact on companies like ours is staggering," says Bob Heckman, MTech's executive vice president of marketing. "The swing in our revenue structure has been away from the small banks. Now 25 to 30 percent of our income comes from big banks." That translates into about $60 million or more—and it comes from only 1 percent of MTech's customer base. Heckman anticipates big banks will represent 50 percent of his company's business in 1988. He also predicts that about half of the big banks will eventually go to third-party data processing, and that most of those will do so over the next two years.

One reason for this success: even the biggest banks' in-house data-processing departments can't help but see themselves falling behind the service companies in the push toward more sophisticated software applications. In-house operations are simply too busy patching old programs and keeping up with regulatory changes to explore new applications. But independent data processors have the resources to create new services, as well as the marketing muscle to sell them. They offer a smorgasbord of software applications that no customer could cook up for itself.

Relational databases, for example, let users arrange customer information in any way they want. This means they can link particular fields of information with any other fields in the database. Files become flexible, established for only as long as they are needed: a minute, a week, or indefinitely. The database also automatically rearranges these combinations in response to the user's questions.

"Before this software was available," says Jim Wilkins, executive vice president of Systematics, "if a banker wanted to know how many loans are secured by mobile homes in a group of nine zip codes and what the collection experience has been on those loans for the past three years, it would have been very difficult if not impossible—even though all the data was there. Now that is quite an easy request."

About 6 to 10 data-processing suppliers are big enough to go after large-scale banking business. The main beneficiaries of the trend are a group of five independent bank processors, including MTech, Systematics, FIserv, First Financial Management, and GM's Electronic Data Systems.

To consolidate their positions, these companies are aggressively buying up many of the approximately 600 third-party bank data processors around the country. "I think the primary trend from here on in will be for existing data processors to increase their market share through acquisitions," says Cato Carpenter, a securities analyst with Alex Brown & Sons.

MTech and First Financial Management have led the way in the mergers-and-acquisitions arena. Within the last three years, each has bought about 15 other data processors. "The main reason for all this activity," explains Carpenter, "is that they are trying to capture a larger customer base in a rush to provide better economies of scale."

Because of the acquisition activity, some analysts predict that the top 10 bank processors will control more than half the business by 1990.

Despite the technological advances, the success of outside data processors depends primarily on saving their customers money. Nowhere is this more true than in the banking industry, where competition brought on by deregulation played havoc with data-processing costs. Before deregulation, large banks spent an average of 8 percent of their noninterest expenses on data processing, according to *Bank Network News*. Today, the proliferation of new financial products has pushed that figure to 15 percent. "Data processing is now the second largest noninterest expense item, right behind occupancy," says Jim Wilkins of Systematics. "For some banks it is even larger than occupancy."

Cost statistics also do not count certain hidden costs, says George Dalton, chairman of FIserv: "For example, when somebody leaves, you have the expense of finding somebody new and training them."

Although cost is the key factor luring customers to outside data processors, new applications based on technological advances will assume increasing importance in the next few years.

One such new application is debit cards, which let users pay for retail goods without cash—and without incurring the interest charges associated with credit cards (see "Money Machines Outgrow Banking," October 1987). MTech offers a typical debit-card application that lets customers of its client banks take advantage of cash discounts at Exxon and Mobil gas stations. MTech handles the costs and hassles of installing the point-of-sale machines, creates the debit cards, and sells the complete service to participating banks. Because the oil companies can't possibly deal with 50 different banks, it's up to the service bureaus and the very largest banks to strike the deals that make these services feasible.

In addition to searching for technically advanced services to offer their customers, the data-processing companies are also exploring technological solutions to cutting their own costs. FIserv, for example, is turning to satellite-based communication systems to help control communications costs. The company is equipping its customers with very-small-aperture terminals, or VSATs, to link them to its remote computer centers.

"All the centers are linked by dedicated phone lines, but in the future the remote sites will be linked via satellite," says FIserv's Dalton. "Satellite communication is reliable because the data doesn't have to pass through switching centers where errors can creep in. It can also be less expensive."

Clients transmit the information via VSATs to a satellite orbiting overhead. The satellite sends the information to Equatorial Communications' satellite hub in Mountain View, Calif. A leased phone line delivers the information to FIserve's operations center. FIserve reverses the process to send the processed information back to the clients.

Outside data processing is clearly on the rebound, but its new concentration on vertical market segments means it will never return to the old days of one-size-fits-all. ■

Free-lance writer Henry Fersko-Weiss specializes in business and technology.

THE TOP 5 PROCESSORS FOR BANKS

COMPANY	ADDRESS	1987 BANK REVENUE (EST.)	MARKET SHARE	BANKING CUSTOMERS
MTech	1712 Commerce St. Dallas, TX 75222 (214) 506-4000	$235 million	8%	1,400
Electronic Data Systems	7171 Forest Lane Dallas, TX 75230 (214) 661-6000	$200 million	7%	1,000
Systematics	40001 Rodney Parham Rd. Little Rock, AR 72212 (501) 223-5100	$142 million	5%	800
First Financial Management	2695 Burford Highway N.E. Atlanta, GA 30324 (404) 325-9715	$104 million	3%	1,000
FIserv	2152 South 114th St. Milwaukee, WI 53227 (414) 546-5014	$80 million	3%	450

SOURCE: ALEX BROWN & SONS/HIGH TECHNOLOGY BUSINESS RESEARCH

Xerox President Paul Allaire

ON THE OFFICE OF TOMORROW

NEARLY 50 YEARS AGO, entrepreneur Chester Carlson made the first xerographic copy. The technique revolutionized document handling in offices; it also made the name of Carlson's company, Xerox, a household word.

Paul A. Allaire, 49, has been a director and president of Xerox since August 1986. He is responsible for the company's business products and systems, a line that extends well beyond copying machines to include word processors, personal computers and workstations, printers, facsimile machines, electronic typewriters, communications networks, and office systems. This expansion has served the company well; with 1986 sales of more than $9 billion, the company ranked 32nd on the *Fortune* 500.

Speaking for a company that's both pioneer and major mover in office automation, Allaire told HIGH TECHNOLOGY BUSINESS assistant managing editor Jeffrey Zygmont about new opportunities emerging as technology reshapes tomorrow's offices.

■ *HT Business: How large is the office-automation business in the United States?*

ALLAIRE: You have to be very careful when using the term "office automation," because I think it means different things to many people. Xerox is concentrating on the document-oriented aspects—document processing. That

Paul A. Allaire

Born: July 21, 1938
Joined Xerox: 1966
Responsibilities: Xerox business products and systems operations; R&D
Revenue controlled: $9.4 billion/year
Employees supervised: 102,000
1987 R&D budget: $700 million

E.J. CAMP

is a huge potential market. As we define it, including electronic printing, by 1995 we expect the market to be somewhere around $80 billion.

The market now is probably a tenth of that size. It's going to be a very large growth market. There are some people who say it'll even go into the home. I'm not sure about that, because I'm not sure about how many people really spend their time at home doing the kind of things that need a degree of automation. But I think even small companies and offices will need document processing. Even the doctor's office, with half a dozen doctors, or a lawyer's office or a consultant's office will need this kind of capability, and it's going to be cheap enough. I think it's less than 10 years away.

■ *HT Business: What must office-equipment suppliers like Xerox do to spur that growth?*

ALLAIRE: We have to make our systems cost-effective. People are not going to buy them for convenience; the systems have to be tools that improve office productivity. That means that we have to provide key applications that solve our customers' problems.

■ *HT Business: Technologically, what is that going to take?*

ALLAIRE: There are two missing steps for practical, economical document processing. The first is electronic scanning and the use of, to some degree, intelligent scanning [scanning systems that recognize the content of documents they scan]. Scanners and intelligent scanners exist now, but clearly their cost has to come down. They'll never quite make it as low as light-lens copying, in our view. But if the economics are down significantly enough, there is incremental value added by having a scanned image, because you can then electronically manipulate it, you can proofread it, you can store it, you can quickly communicate it over distances. By the end of the '80s there will be an economical system.

The other missing piece is electronic filing. The medium for filing exists now; the real issue is having intelligent software that lets you access those files in the same way people access files in an office today. We all have some kind of system that lets us search—what we call "unstructured" filing. If you have to keep a list of files somewhere and then do a manual search to find out what you have in an electronic file, retrieval becomes the big bottleneck. People will be reluctant to file electronically if they can't be absolutely sure they're going to get something back when they need it.

Combining filing and scanning gives two big advantages. One is the compression you can do if you're dealing with encoded data rather than recorded images. You use substantially less data-filing space, and by sending less information, you are also flexible in your communications requirements.

The second advantage, obviously, is if you have a document in your system intelligently, then you can do more intelligent searches; you don't have to just deal with the subject matter and the date. Intelligent scanning will enable you to do intelligent retrieval and therefore it will promote more complete, more common use of electronic filing as it becomes significantly cheaper.

■ *HT Business: When will paper disappear from offices?*

ALLAIRE: That's an easy question to answer: never. I think the industry has thought out the paperless office and we have finally come to recognize that paper is a user-friendly medium. We think paper will always be used, and we see a continuation of growth in copy-making and printing, certainly to the end of the century, at least. That does not mean that a lot of things that used to be handled on paper are not now done electronically.

For example, we at Xerox used to distribute paper by hand. Now, from workstations, we send all our mail electronically. We have a system that links staff all over the world. So I can write a letter, or write a note on a letter that comes in to me, and send it back.

The other big area that I think is going to impact paper use is electronic filing. When we can do electronic filing and, most importantly, retrieval, in an expeditious manner—which is coming very, very quickly—that will cut down again on the number of copies made.

Another big change has already happened. A lot of people used to print a hundred copies of a report and put them on the shelf. If we have that report stored electronically, we can now print on demand.

■

"To approach the total market you're going to have to offer integration. That's what customers are going to look for."

■

On the other hand, we're also doing more drafts, more iterations, with more involvement from other people in creating a document. So by increasing ease in communications, we're increasing the number of documents that exist in electronic and paper form.

■ *HT Business: It's important to integrate different devices and systems in an office so they communicate. As the document-processing industry grows, does it face a latent threat of putting out systems that don't work together?*

ALLAIRE: It's not only a latent threat; there are systems that won't talk together already. Clearly, integration and standardization will occur, and it won't be without pain. But you have to be able to work from one manufacturer's system into other people's systems. You have to be able to communicate over novel communication vehicles. You have to have protocols so that, if I am sending a document, you can recognize what that document is, and if it's an encoded document, you can change it into a form you can recognize on your computer screen or can print out. And you have to do that with a reasonable degree of convenience. Otherwise the market won't develop. But manufacturers recognize this.

■ *HT Business: You say the coming of standards is going to be painful. For whom?*

ALLAIRE: It will be painful for the equipment makers, initially. And if we don't get our act together quickly it will be painful for the customer, because clearly customers are going to want to be able to steadily upgrade their capabilities, and do it without having a massive conversion effort as they go from one level of sophistication to another. It's going to be very difficult to sell to a customer if you say, "Look, I have a great solution for you. It's 25 percent better than what you have now, but by the way, you have to throw away everything you have and nobody else will be able to talk to you."

It's happening slowly. People are recognizing it. Nobody is smart enough to say what the world is going to look like in 1995 and therefore nobody knows exactly what set of standards we have to have. In each of the critical areas there will probably be more than one standard, but there will be a few accepted standards and they will work together.

■ *HT Business: What will happen to companies that don't conform to standards?*

ALLAIRE: Well, if you don't conform to standards you're going to have to offer something else that's a pretty significant advantage.

■ *HT Business: As integration becomes more necessary, will it squeeze out small, single-product suppliers?*

ALLAIRE: There will always be some customers for stand-alone products. We believe there will always be some stand-alone copiers, for example, at the low end of the market.

There will also be a lot of companies that are not manufacturers but that are doing systems integration. You see that already—people who say to a customer, "You have a need. I will pick the best components and put them together for you and give you a custom system." The stand-alone manufacturers will still play into that kind of environment.

The other thing is, as some systems become more standard, you'll be able to plug into anybody's system. For example, there are now standards for facsimile machines. You really don't have to be in the whole document-processing or systems-integration environment to be a manufacturer of facsimile devices, because they will plug into the telephone system and probably other systems as well.

I'm not suggesting that everybody not into systems integration will go out of business. But I think if you want to approach the total market you're going to have to offer integration, because that's what customers are going to look for—a solution to their total problem, not a piece of hardware.

■ *HT Business: Much has been said about how office productivity has not increased despite massive spending on office automation. Does that bode ill for your business?*

ALLAIRE: In my view, the biggest requirement in industry today is to improve office productivity. It has not kept up with productivity improvements on the manufacturing side. To compete in the '90s, a company has to be cost-effective in all areas. For most businesses, most of the jobs are in the white-collar area.

Document processing is a tool to improve productivity. As with any other tool, you can use it properly, or you can misuse it, or you can spend money on it and not use it. By itself it is not a panacea.

The evolution or revolution of electronic office technology is inevitable because of this need for productivity. So I am not concerned about the statistics on office productivity, because if we have the right tools, companies are going to pick up those tools. I don't want to be naive. Companies have to change the way they operate to take advantage of the tools, and that's not easy. But look at the better companies; ask their chief executive officers what's on their minds. These are the things they will talk about. So it's going to happen.

■ *HT Business: In other words, efficient offices are becoming a competitive advantage for companies?*

ALLAIRE: If you don't have one, you're going to be competitively disadvantaged.

■ *HT Business: Computer companies also sell equipment for offices. Do you consider them major competition?*

ALLAIRE: Well, everybody is interested; all potential suppliers see it as a big market. When I say everybody, I mean both the data-processing companies like IBM and DEC, and the telecommunications people. Everyone's coming at the market from their areas of strength—the data-processing companies through computers, and telecommunications companies through the PBX [private branch exchange]. Companies like Xerox that have been more office- and document-oriented are coming at it from our area of knowledge and expertise. We will all be players.

■ *HT Business: Your company recently diversified into financial services. Does that mean it's been tough to make it in business products alone?*

ALLAIRE: We got into the financial-services business so we would have what we consider two legs. We were looking for a business that is mainly in the United States, not overseas, and one that is not influenced by currency swings. We did not want a business in which we had the same Japanese competition, or that was on the same cycles, as business products. The reason is to assure the financial strength of the company, so that we can pursue both profitable financial-service business opportunities and also, on a continuous basis, the business-product side.

The investments we've made in financial services have not in any way diminished the investments we're making in business products. We have increased our research and development in business systems every year. We have a development budget of about $670 million this year, and I think it was about $600 million last year.

■ *HT Business: Does the fact that the name Xerox is synonymous with copiers make it hard to sell your many other office products?*

ALLAIRE: Copying is what enabled Xerox to become the $14-billion company that it will be this year, so from that standpoint it's clearly a blessing. But any company that has that strong an image to some degree does not get credit for all the other things it does, and we have that problem.

But I don't think it's a big problem for us. As we grow and are more successful, we will get that recognition. In all the things that we do, the Xerox name is a very strong, very positive image for the company. People want to do business with us because we are Xerox, and we have earned a very good reputation.

That started with copiers; so be it. I can't think of a name I'd like to have better. ■

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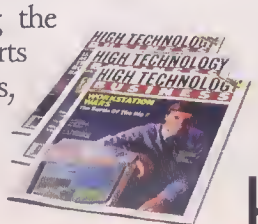

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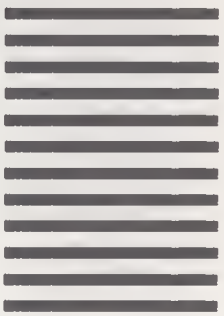

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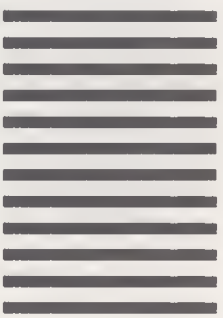

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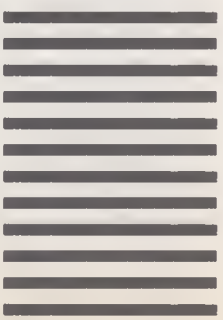

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Lasers Power Printers, Copiers

OFFICE PRODUCTS

Color laser copier. A digital copier that allows editing and graphics layout using photos, slides, or negatives. Offers shades of four colors. $34,500. Canon USA Inc., Copier Products Div., 1 Canon Plaza, Lake Success, NY 11042. (800) 652-2666. *Circle 1.*

AP800 typewriters. Various models offer a choice of liquid-crystal or screen displays. Features include automatic formatting, correction memory, and a keyboard that accepts hardware and software options. $799 to $1,599. Canon USA Inc., Office ETW/WP Group, 1 Canon Plaza, Lake Success, NY 11042. (516) 488-6700. *Circle 2.*

2019/3019 laser printers. These printers emulate the IBM 3812 printer to handle documents wider than 80 columns. Both models integrate text with graphic elements. The 2019 prints 10 pages/minute; the 3019, 18 pages/minute. $6,995 and $10,995. Lexi Computer Systems Corp., 231 Sutton St., Suite 1D, North Andover, MA 01845. (617) 681-1118. *Circle 3.*

2087/3087 laser printers. Switchable RS-232 interfaces permit connection to personal computers; the toner cartridge lasts for 3,000 pages. These printers emulate the IBM 3287, 4214-2, and 3268 units. $6,995 and $10,995. Lexi Computer Systems Corp., 231 Sutton St., Suite 1D, North Andover, MA 01845. (617) 681-1118. *Circle 4.*

Fax-350 facsimile machine. This desktop model uses thermal printing to produce copies on plain paper. Transmits half-tones in 16 shades of gray for sending artwork. $2,895. Canon USA Inc., Facsimile Div., 1 Canon Plaza, Lake Success, NY 11042. (516) 488-6700. *Circle 5.*

Faxgard facsimile protector. This surge suppressor protects facsimile machines from AC and telephone-line electrical surges, spikes, and noise. $99. Sutton Designs Inc., Computer Security Div., 300 North Tioga, Ithaca, NY 14850. (607) 277-4301. *Circle 6.*

Fax-L920 facsimile machine. A plain-paper unit that handles multiple files with a 32-megabit memory; stores 65 pages. Memory may be expanded to hold 238 pages. $7,995. Canon USA Inc., Facsimile Div., 1 Canon Plaza, Lake Success, NY 11042. (516) 488-6700. *Circle 7.*

ImageStation/S, 2308/S printers. Both use a Canon LBP-SX engine and produce eight pages/minute. Input tray holds 200 pages; toner cartridge lasts for 4,000 pages. $5,595 and $8,950. Imagen, Box 58101, Santa Clara, CA 95052. (408) 986-9400. *Circle 8.*

Keydex UG-403 printer sharer. Connects as many as four computers to one or two parallel printers. $360. Computer Friends, 14250 NW Science Park Dr., Portland, OR 97229. (503) 626-2291. *Circle 9.*

Kowin Three computer. A multiple-user system built around a 68020 32-bit processor. Has a 40-megabyte hard disk expandable to one gigabyte and runs under the Unix V.3 operating system. Less than $2,000/user. Kowin Computer Corp., 830 N. Wilcox, Montebello, CA 90640. (800) 445-6946; in CA, (800) 225-6946. *Circle 10.*

LANstation workstations. Three diskless units for local-area networks. The Turbo XT model has an 8088 processor and runs at 8 megahertz; the other models use an 80286 processor and run at 10 or 12.5 megahertz. $599 to $1,279. Racore Computer Products Inc., 170 Knowles Dr., Los Gatos, CA 95030. (408) 374-8290. *Circle 11.*

NP-3525EF copier. Has an image editor and document feeder; offers two-color printing, automatic two-page separation, zoom, enlargement and reduction. Prints 27 copies/minute, first copy in seven seconds. $6,195. Canon USA Inc., Copier Products Div., 1 Canon Plaza, Lake Success, NY 11042. (800) 652-2666. *Circle 12.*

PayCalc payroll calculator. Stores federal, state, and local tax information in a plug-in cartridge to perform complex payroll calculations. $439.95. Bastech Computer Co., 4250 W. 3rd St., Los Angeles, CA 90020. (800) 553-2727. *Circle 13.*

RuggedWriter 480 printer. This 24-wire, serial impact, dot-matrix printer produces 480 characters/second in draft mode, 240 characters/second for letter-quality. Handles spreadsheets, multiple-part forms, reports. $1,695. Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, CA 94304. (800) 752-0900. *Circle 14.*

Sign-On signature verifier. Uses smart cards to restrict access to sensitive computer data by measuring how users write their signatures. $990. Signify Inc., 9005 Red Branch Rd., Columbia, MD 21045. (301) 992-3035. *Circle 15.*

COMPUTER HARDWARE

Colorscan/2 graphics workstation. Combines the capabilities of an IBM PS/2 or PC XT/AT-compatible computer with the communications and graphics capabilities of DEC's VT240 terminal. From $2,000. Datamedia Corp., 11 Trafalgar Square, Nashua, NH 03063. (603) 886-1570. *Circle 16.*

DOS Expander memory board. Extends active DOS memory to 704 kilobytes, then adds 192 kilobytes for memory-resident programs, random-access memory disks, and print spoolers. $279. Technology Business Strategies Inc., 20 Main St., Ashland, MA 01721. (617) 881-7322. *Circle 17.*

EL and GP computers. Model EL includes an electroluminescent display, composite video output, one megabyte of random-access memory, a floppy-disk drive, and mouse. $4,995. Model GP has similar features, but a gas-plasma screen. $3,995. Dynamac Computer Products Inc., 1536 Cole Blvd., Suite 252, Golden, CO 80401. (303) 233-0305. *Circle 18.*

FileCard PS30 hard disk drive. Made for the two-floppy-drive version of the IBM Personal System/2 Model 30 computer; adds 32 megabytes of storage. $995. Western Digi-

tal, 2445 McCabe Way, Irvine, CA 92714. (714) 863-0102. *Circle 19.*

Graphics adapter/controller boards. Handle business graphics, desktop publishing, and computer-aided design. All three boards work with the IBM PC and compatible computers. From $100. Thomson Consumer Products Corp., 5731 W. Slauson Ave., Suite 111, Culver City, CA 90230. (213) 568-1002. *Circle 20.*

MagniView 200 display. A liquid-crystal panel that projects personal-computer text and graphics. Works with any IBM-compatible or Apple II computer. $1,195. Dukane Corp., 2900 Dukane Dr., St. Charles, IL 60174. (800) 634-2800; in IL, (312) 584-2300. *Circle 21.*

Microsoft mouse. Works with the IBM PC, the Personal System/2, and compatible computers. $150 to $200. Microsoft Corp., Box 97017, Redmond, WA 98073. (206) 882-8080. *Circle 22.*

RAMdrive memory enhancement. This one-megabyte, battery-powered device permits program and data storage in random-access memory. The unit always stays on and automatically backs itself up several times a day. $599. Technology Business Strategies Inc., 20 Main St., Ashland, MA 01721. (617) 881-7322. *Circle 23.*

COMPUTER SOFTWARE

Bookends PC database manager. To help track down articles, magazines, and books, this program stores such data as author, journal, volume, publisher, editor, keywords, and abstracts on an IBM PC. Creates bibliographies in any format. $149.95. Sensible Software Inc., 335 E. Big Beaver, Suite 207, Troy, MI 48083. (313) 528-1950. *Circle 24.*

ClickArt PS Art image library. Contains more than 125 pieces of art for desktop publishing with Macintosh and IBM-compatible computers. Works with several software packages. $129.95. T/Maker, 1973 Landings Dr., Mountain View, CA 94043. (415) 962-0195. *Circle 25.*

Design To Print software. A desktop-publishing program for IBM PCs and compatible computers that creates posters, flyers, cards, banners, and newsletters. $49.95. Britannica Software, 185 Berry St., San Francisco, CA 94107. (415) 546-1866. *Circle 26.*

Desktop Express electronic mail. Lets Macintosh users send and receive graphics and text over MCI Mail. $149. Dow Jones Software, Box 300, Princeton, NJ 08543. (609) 520-4642. *Circle 27.*

Filer 1099 IRS-form filer. Handles all 1099 forms except 1099G for businesses required to file on a floppy. Controls totals and generates five printed reports; also updates records and prints forms and labels. $149 for the first form, $99 for each additional form; $495 buys all eight forms. Nichols Software, 5295 Galaxie Drive E-7, Jackson, MS 39206. (601) 981-9336. *Circle 28.*

Laser Fonts and Fancy Font programs. These programs offer 18 fonts and use WordPerfect format codes. Laser Fonts works with Hewlett-Packard LaserJet+, Series II, Canon printers, and compatible laser printers; Fancy Font works with the Epson FX, MX, LQ Toshiba, and compatible dot-matrix printers. $180 and $210, respectively. SoftCraft Inc., 16 N. Carroll St., Suite 500, Madison WI 53703. (608) 257-3300. *Circle 29.*

Lookup spelling checker. Runs on the Macintosh while working in any program. The package has a 60,000-word dictionary for use with 400-kilobyte systems and a 93,000-word dictionary for computers with more memory. $49.95. Working Software Inc., 321 Alvarado, Suite H, Monterey, CA 93940. (408) 357-2828. *Circle 30.*

Paint Write Draw programs. Running on the Apple IIGS, this package offers painting, graphics, animation, and word processing with graphics. Includes a library of 650 color images. $179.95. Activision Inc., Box 7286, Mountain View, CA 94039. (800) 663-4263; in CA, (415) 960-0518. *Circle 31.*

PCDA serial-data analyzer. Lets IBM PCs and compatible computers with serial ports capture and display serial communications between two devices. Needs no additional boards. $95. Triple C Software, 800 W. Oakland Park Blvd., Fort Lauderdale, FL 33311. (305) 564-8011. *Circle 32.*

Postcards graphics library. Contains offbeat art and bizarre backgrounds that combine with text to create postcards, invitations, office notes, etc. $24.95 for MS-DOS, Commodore 64/128, and Apple IIe and IIc versions; Apple IIGS and Macintosh versions cost $29.95. Activision Inc., Box 7286, Mountain View, CA 94039. (415) 960-0410. *Circle 33.*

StyleWriter software. Creates headlines, copy, and graphics. $1,495. GBC, 1 GBC Plaza, Northbrook, IL 60062. (800) 342-5422. *Inquire directly.*

Summa Software Series phone manager. Collects, sorts, prices, and reports calls; needs no buffer boxes or peripheral devices. Runs on the IBM PC/XT. $1,595. Summa Four Inc., 2456 Brown Ave., Manchester, NH 03103. (603) 625-4050. *Circle 34.*

Surpass spreadsheet. This program loads and links multiple spreadsheets simultaneously; it lets users manage their hard disk without quitting Surpass. A subset program provides the commands, formulas, files, and macros of Lotus 1-2-3. $495. Surpass Software Systems Inc., 14 Commercial Blvd., Suite 131, Novato, CA 94949. (415) 382-8840. *Circle 35.*

Tally Ho! financial calculator. A memory-resident program that pops up or stands alone. Its 40 functions include debugging, index summary, amortization calculations, statistics, and printing. Runs on IBM or compatible computers. $49.95. ChipSoft Inc., 5045 Shoreham Place, Suite 100, San Diego, CA 92122. (619) 453-8722. *Circle 36.*

Time Line Graphics 1.1 add-on. Provides graphic output on laser and dot-matrix printers and plotters. The program works with Time Line, the company's project-management software for the IBM PC. $195; $99 for Time Line users. Symantec Corp., Breakthrough Software Div., 505-B San Marin Dr., Novato, CA 94945. (415) 898-1919. *Circle 37.*

Tree86 DOS enhancement. Creates a graphics tree on disk to make, rename, and change directories, back up files, change attributes, and view files. Works with mouse or keyboard on the IBM Personal System/2 and PC/XT/AT. $49.95. Aldridge Co., 2500 City West Blvd., Suite 575, Houston, TX 77042. (713) 953-1940. *Circle 38.*

TWP machine translator. Running on the IBM PC and compatible computers, this program translates Spanish, Russian, or French documents into English as fast as 3,500 words/hour. $28.75. Translation Services, 1951 Kidwell Drive, Vienna, VA 22180. (703) 790-0410. *Circle 39.*

COMMERCIAL/INDUSTRIAL

SCID security device. For remote personal computers using TraqNet systems, this device verifies the identity of callers accessing a host computer over dial-up telephone lines. $295 to $750. LeeMah DataCom Security Corp., 3948 Trust Way, Hayward, CA 94545. (800) 992-0020; in CA, (800) 824-9369. *Circle 40.*

1210/1220/1240/1285 workstations. Made for the 3270, System/3X, PBX, and airline networks. Three models use the 80286 processor and offer such options as an 80287

math coprocessor and Arcnet or Ethernet chips and adapter boards. Model 1285 has an 80386 processor and optional 80387 coprocessor. $1,500 to $3,170. Telex Computer Products Inc., 6422 E. 41st St., Tulsa, OK 74135. (918) 627-1111. *Circle 41.*

8638 label printer. Thermally prints bar codes as fast as five inches/second. From $5,995. Intermec Corp., Box 360602, Lynnwood, WA 98046. (206) 348-2600. *Circle 42.*

Anza neural-network computer. Includes the Zenith 386 AT-compatible host with a 16-megahertz processor, one megabyte of memory, an 80-megabyte hard disk, a 13-inch color monitor, and a coprocessing board. $19,950. Hecht-Nielsen Neurocomputer Corp., 5893 Oberlin Dr., San Diego, CA 92121. (619) 546-8877. *Circle 43.*

BL8000 shared-database system. Lets mainframes, minicomputers, and personal computers share information. $320,000. Britton Lee Inc., 14600 Winchester Blvd., Los Gatos, CA 95030. (408) 378-7000. *Circle 44.*

Blast II VAX-communications program. Using a Lotus-style menu, this product eases communications with a VAX computer. Virtual-terminal capabilities for VAX/VMS permit interaction with other computers. $250 to $1,295. Communications Research Group, 5615 Corporate Blvd., Baton Rouge, LA 70808. (800) 242-5278. *Circle 45.*

Bus-65517 converter card. Turns an IBM PC into a workstation for development, emulation, and analysis of Mil-Std-1553 systems. $8,995. ILC Data Device Corp., 105 Wilbur Place, Bohemia, NY 11716. (800) 332-1772; in NY, (516) 567-5600. *Circle 46.*

Custom interconnection systems. These systems survive hostile environments by using Kryoflex hermetically sealed connectors and molded cable assemblies. Flexible metal sheaths guard against electromagnetic and radio-frequency interference. Price varies. Kyle Technology Corp., PSC Div., 3500 NW Stewart Pkwy., Roseburg, OR 97470. (503) 672-5953. *Circle 47.*

DMS document manager. Based on a personal computer, this workstation operates independently or as a network to produce documents such as manuals, books, and catalogs. $595 to $8,000. Bestinfo Inc., 1400 N. Providence Rd., Suite 117, Media, PA 19063. (215) 891-6500. *Circle 48.*

Focus 196 PBX phone system. A digital system that handles 240 stations and 40 trunks. Automatically distributes calls, records messages, and permits simultaneous voice/data transmission. $425/line. Fujitsu Business Communications, 3190 Mira Loma Ave., Anaheim, CA 92806. (714) 630-7721. *Circle 49.*

Focus 9600 PBX phone system. A digi-

tal, nonblocking switch that uses distributed processing. Works with conventional public or private networks, plus T1, ISDN, DMI, and Packet networks. Price varies. Fujitsu Business Communications, 3190 Mira Loma Ave., Anaheim, CA 92806. (714) 630-7721. *Circle 50.*

GR27S1 board tester. Performs in-circuit testing of application-specific integrated circuits and VLSI printed-circuit boards. $450,000 to $700,000. GenRad Inc., 300 Baker Ave., Concord, MA 01742. (617) 369-4400. *Circle 51.*

HSM-21S solder mask. Made from blends of advanced polymers that ensure adhesion, provide fine-line definition on circuitry, and accept ink. Meets UL and military specifications. $50 to $90/gallon. Columbia Chase, Humiseal Div., Box 445, Woodside, NY 11377. (618) 932-0800. *Circle 52.*

HSM-1000 inspection system. A noncontact laser system that gauges thickness to eliminate defects in pouch-filled powder products. $28,110. Selcom Selective Electronic Inc., Box 250, Valdese, NC 28690. (704) 874-4102. *Circle 53.*

LXE Handler/1000 software. Connects Hewlett-Packard 1000 minicomputers to LXE's hand-held, wireless data terminals. $5,500. Comsci Data Systems, Box 20101, Atlanta, GA 30325. (404) 352-3533. *Circle 54.*

Micro 1110/1120 datacom modules. These units extend the RS-232 interface, using fiber-optic connectors with a fiber link as long as two kilometers. $250/end. Versitron, 6310 Chillum Place NW, Washington, DC 20011. (202) 722-8600. *Circle 55.*

Miniature X-Y positioners. Mount anywhere to manually fine-tune and lock sensitive instruments into position. $150. Charles Supper Company Inc., 15 Tech Circle, Natick, MA 01760. (617) 655-4610. *Circle 56.*

Model HP transducer. Measures pressures as high as 100,000 pounds/square inch. Made of stainless steel with an AE-F250-C-style pressure port. Price varies. Sensotec, 1200 Chesapeake Ave., Columbus, OH 43212. (614) 486-7723. *Circle 57.*

Protoboard prototype panels. Electrically tested on a bed-of-nails tester; has a 0.1-inch hole pattern to accommodate various packaging types. $485 to $1,700. Multiwire/East, 250 Miller Place, Hicksville, NY 11801. (516) 933-8300. *Circle 58.*

Q-Net system integrator. Accommodates 16 operating systems to connect mainframes, minicomputers, multiple-user systems, personal computers, and local-area networks. Has 32 to 128 ports. $7,995 to $13,795. Microscience Corp., 8601 Dunwoody Place, Suite 136, Atlanta, GA 30350. (404) 998-6551. *Circle 59.*

R370 spectrum analyzer. Working with the IBM PC/XT/AT or compatible computers, this product offers analyzer and digital-oscilloscope functions. $4,495. Rapid Systems Inc., 433 N. 34th St., Seattle, WA 98103. (206) 547-8311. *Circle 60.*

Series 1S computer numerical control. This system uses artificial intelligence to handle such complex tasks as die sinking and machining. Has a 32-bit 68020 processor. Price varies. GE Fanuc, 114 Mayfield Ave., Edison, NJ 08818. (800) 648-2001; in NJ, (518) 377-3381. *Circle 61.*

Series S0S I/O modules. An expandable system that meets U.S. and international standards for programmable logic controllers. $219 to $3,548. Texas Instruments Inc., Data Systems Group, Industrial Systems Div., Box 809064, IUZE1, Dallas, TX 75380. (615) 461-2648. *Circle 62.*

Smallframe computer. A mainframe computer the size of a minicomputer. Offers 48-bit processing. $25,000 to $145,000. Unisys Corp., Box 500, Blue Bell, PA 19424. (215) 542-4673. *Circle 63.*

Sun-4 workstations. Run 10 million instructions/second to rival the performance of a VAX 8800 system. Suited for computer-intensive, floating-point, or graphics-intensive applications. $36,900 to $104,900. Sun Microsystems, 2550 Garcia Ave., Mountain View, CA 94043. (415) 960-1300. *Circle 64.*

Topaz-II design verifier. Lets engineers test prototypes of high-speed, application-specific integrated circuits with many gates at full speed. Features include color control screens, 100-picosecond resolution on programmable delays, and DC parametric measurements on all pins. Hilevel Technology Inc., 18902 Bardeen, Irvine, CA 92715. (714) 752-5215. *Circle 65.*

VC6800 vacuum systems. Comes with either a three-source resistive gun or a multiple-hearth deflection electron-beam source for enhanced evaporation. Options include a 750-degree-Celsius substrate heater. $33,000 to $40,000. BioRad Polaron Div., 19 Blackstone St., Cambridge, MA 02139. (800) 524-8200; in MA, (617) 524-8200. *Circle 66.*

■ MANUFACTURING SUPPLIES

Barrier terminal blocks. Molded with barriers between terminals for higher electrical ratings and protection against shorts from frayed wire. 47 cents to $10.07 each in lots of 1,000. TRW, Cinch Connectors, 1501 Morse Ave., Elk Grove Village, IL 60007. (312) 981-6000. *Circle 67.*

LMA9000 gate arrays. These arrays use the company's Channel-Free architecture, which lets designers add 4 kilobits of random-access memory on a chip with typical cycle times of less than 15 nanoseconds. Internal propagation delays are typically 0.57 nanoseconds. Price varies. LSI Logic Corp., 1551 McCarthy Blvd., Milpitas, CA 95035. (408) 433-7337. *Circle 68.*

P44 panel light. This light-emitting diode lamp projects 0.035 inches above the panel. From 60 cents each in lots of 1,000. Data Display Products, Box 91072, Los Angeles, CA 90009. (213) 640-0442. *Circle 69.*

XR-T82S1S/16 Starlan transceiver. This chip set supports multipoint extension as well as STAR and Bus topologies. It connects local-area network cables with the network controller. $17.50 each in lots of 1,000. Exar Corp., Box 49007, San Jose, CA 95161. (408) 434-6400. *Circle 70.*

■ CONSUMER PRODUCTS

DL-400 Tele camera. Has a 35/70-mm lens and offers automatic exposure and focusing. The camera automatically switches to close-up focusing when its lens comes within 35 inches of the subject. $319.95. Fuji Photo Film USA Inc., 555 Taxter Rd., Elmsford, NY 10523. (914) 789-8100. *Circle 71.*

EL-S09S/EL-S31A calculators. The 509S has 56 statistical and scientific functions and 16 calculator functions, plus store, recall, and add-to-memory keys. The 531A has an eight-digit display and 61 functions. $15.95 and $12.95, respectively. Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430. (201) 529-9526. *Circle 72.*

PCC remote control. Works with 18 brands of color TV, 19 brands of VCR, and eight cable converters. $39.95. Zenith Electronics Corp., 1000 Milwaukee Ave., Glenview, IL 60025. (312) 391-8181. *Circle 73.*

Personal Portfolio Manager service. Evaluates as many as 20 stocks; presents investment ideas arranged by risk in eight model portfolios. $300/year for a charter subscription; $39 for 10-week trial. Infocomm Systems Inc., Titicus Rd., Purdys, NY 10578. (914) 669-8100. *Circle 74.*

1438 Tully Rd. Atlonto, GA 30329 (404) 325-4843	equipment for the music industry.	chairman		
Generotion 5 Tech. (GFIVU) 8670 Wolff Court Denver CO 80030 (303) 427-0055	To market computer-oided design systems ond services.	$1.8 million from initial public offering	Fronk Richordson, president	Computer Connection Ltd., president
GO 139 Townsend St. Son Froncisco, CA 94107 (415) 543-3200	To develop new softwore ond hordwore for personal computing, oimed ot professionols ond managers.	Undisclosed funding from Kleiner, Perkins, Coufield & Byers	Jerrold Koplon, president, CEO Robert M. Corr, v.p. software	Lotus Development, principol technologist Ashton-Tote, chief scientist
Hecht-Nielsen Neurocomputer 5893 Oberlin Dr. Son Diego, CA 92121 (619) 546-8877	To supply hordwore ond software for research and development of neural networks. First product—Anza neurocomputing coprocessor system—now on market.	Undisclosed funding fram o venture-capital consortium	Robert North, president	TRW, v.p. Electronic Systems Group
I-Logix 22 Third Ave. Burlington, MA 01803 (617) 272-8035	To develop ond morket softwore for outomoting system development.	$3.25 million first-round financing	Peter A. Chiasson, president Shmuel Halevi, v.p.	Computervisian, v.p. electronic systems Scitex, directar of marketing
Materiols Characterizatian Lab. 704 Corporations Park Scotio, NY 12302 (518) 346-6772	To provide speciolized engineering services, including testing of structural materials.	$350,000 from Schenectady Trust and other sources	Roy Williams, president Woyne Andrews, v.p.	GE, Turbine Technology Lob, materiols-testing engineer Knolls Atomic Power Lab., materiols-testing engineer
Metheus (METH) 5510 N.E. Elam Young Hillsboro, OR 97124 (503) 640-8000	To design, manufocture, ond sell computer grophics-disploy products.	$6.6 million from initial public offering	Gene Chao, president, CEO Thomos Hein, v.p. finance and odministration	Tektranix, founder, Applied Research Group Memorex, finance monoger, international group
StepperVision 329 N. Bernordo Ave. Mountain View, CA 94043 (415) 960-1176	To market the Stepper image manitor, a device thot provides optimal settings for semi-conductor-production comeras that transfer design imoges onto silicon.	Undisclosed financing from test-site componies	Warth Z. Ludwick, president, CEO Shelby H. Carter Jr., chairman	Xerox, director, externol-business development, Polo Alto Reseorch Center Xerox, v.p.
Qubix Grophic Sys. (QBX) 1255 Parkmoore Ave. San Jase, CA 95126 (408) 292-4000	To produce graphics workstatians for carporate, government, ond commerciol publishers.	$6.5 million fram initial public offering	Neal Dempsey, president, CEO Timothy Conley, v.p. finonce, treasurer	Envision Tech, president, CEO Zentech, senior v.p. finance
Unigene Labs. (UGNEU) 110 Little Falls Rd. Caldwell, NJ 07006 (201) 882-0860	To provide laboratory services for genetic engineering.	$11.5 million from initial public offering	Worren P. Levy, president	Roche Institute of Molecular Biology, postdoctorol fellow

products. $28,110. Selcom Selective Electronic Inc., Box 250, Valdese, NC 28690. (704) 874-4102. *Circle 53.*

LXE Handler/1000 software. Connects Hewlett-Packard 1000 minicomputers to LXE's hand-held, wireless data terminals. $5,500. Comsci Data Systems, Box 20101, Atlanta, GA 30325. (404) 352-3533. *Circle 54.*

Micro 1110/1120 datacom modules. These units extend the RS-232 interface, using fiber-optic connectors with a fiber link as long as two kilometers. $250/end. Versitron, 6310 Chillum Place NW, Washington, DC 20011. (202) 722-8600. *Cirele 55.*

Miniature X-Y positioners. Mount anywhere to manually fine-tune and lock sensitive instruments into position. $150. Charles Supper Company Inc., 15 Tech Circle, Natick, MA 01760. (617) 655-4610. *Circle 56.*

Model HP transducer. Measures pressures as high as 100,000 pounds/square inch. Made of stainless steel with an AE-F250-C-style pressure port. Price varies. Sensotec, 1200 Chesapeake Ave., Columbus, OH 43212. (614) 486-7723. *Circle 57.*

Protoboard prototype panels. Electrically tested on a bed-of-nails tester; has a 0.1-inch hole pattern to accommodate various packaging types. $485 to $1,700. Multiwire/East, 250 Miller Place, Hicksville, NY 11801. (516) 933-8300. *Circle 58.*

Q-Net system integrator. Accommodates 16 operating systems to connect mainframes, minicomputers, multiple-user systems, personal computers, and local-area networks. Has 32 to 128 ports. $7,995 to $13,795. Microscience Corp., 8601 Dunwoody Place, Suite 136, Atlanta, GA 30350. (404) 998-6551. *Circle 59.*

Corp., Box 300, Blue Bell, PA 19424. (215) 542-4673. *Circle 63.*

Sun-4 workstations. Run 10 million instructions/second to rival the performance of a VAX 8800 system. Suited for computer-intensive, floating-point, or graphics-intensive applications. $36,900 to $104,900. Sun Microsystems, 2550 Garcia Ave., Mountain View, CA 94043. (415) 960-1300. *Circle 64.*

Topaz-II design verifier. Lets engineers test prototypes of high-speed, application-specific integrated circuits with many gates at full speed. Features include color control screens, 100-picosecond resolution on programmable delays, and DC parametric measurements on all pins. Hilevel Technology Inc., 18902 Bardeen, Irvine, CA 92715. (714) 752-5215. *Circle 65.*

VC6800 vacuum systems. Comes with either a three-source resistive gun or a multiple-hearth deflection electron-beam source for enhanced evaporation. Options include a 750-degree-Celsius substrate heater. $33,000 to $40,000. BioRad Polaron Div., 19 Blackstone St., Cambridge, MA 02139. (800) 524-8200; in MA, (617) 524-8200. *Circle 66.*

■ MANUFACTURING SUPPLIES

Barrier terminal blocks. Molded with barriers between terminals for higher electrical ratings and protection against shorts from frayed wire. 47 cents to $10.07 each in lots of 1,000. TRW, Cinch Connectors, 1501 Morse Ave., Elk Grove Village, IL 60007. (312) 981-6000. *Circle 67.*

LMA9000 gate arrays. These arrays use

■ CONSUMER PRODUCTS

DL-400 Tele camera. Has a 35/70-mm lens and offers automatic exposure and focusing. The camera automatically switches to close-up focusing when its lens comes within 35 inches of the subject. $319.95. Fuji Photo Film USA Inc., 555 Taxter Rd., Elmsford, NY 10523. (914) 789-8100. *Circle 71.*

EL-509S/EL-531A calculators. The 509S has 56 statistical and scientific functions and 16 calculator functions, plus store, recall, and add-to-memory keys. The 531A has an eight-digit display and 61 functions. $15.95 and $12.95, respectively. Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430. (201) 529-9526. *Circle 72.*

PCC remote control. Works with 18 brands of color TV, 19 brands of VCR, and eight cable converters. $39.95. Zenith Electronics Corp., 1000 Milwaukee Ave., Glenview, IL 60025. (312) 391-8181. *Circle 73.*

Personal Portfolio Manager service. Evaluates as many as 20 stocks; presents investment ideas arranged by risk in eight model portfolios. $300/year for a charter subscription; $39 for 10-week trial. Infocomm Systems Inc., Titicus Rd., Purdys, NY 10578. (914) 669-8100. *Circle 74.*

MARKETWATCH

NEW COMPANIES

COMPANY (STOCK SYMBOL)	BUSINESS OBJECTIVE	FINANCING	OFFICERS	OFFICERS' PREVIOUS POSTS
Cell Technology (CELL) 1668 Valtec Lane Boulder, CO 80301 (303) 443-8155	To develop products that modify the body's response to disease.	$8 million from initial public offering	Terrance Schreier, president Richard W. Urban, exec. v.p.	HealthCare Systems, exec. v.p., CEO Independent researcher
E3 88 Steamwhistle Dr. Ivyland, PA 18974 (215) 322-6840	To design and manufacture automated optical-inspection systems for semiconductor materials.	More than $500,000 from parent company, ESC	David C. Campbell, president Robert E. Fariss, exec. v.p.	ESC, president (current) ESC, exec. v.p. (current)
Gambatte 1438 Tully Rd. Atlanta, GA 30329 (404) 325-4843	To design and manufacture digital, wireless equipment for the music industry.	$85,000 from chairman	Stuckey McIntosh, chairman	Lantel, exec. v.p.
Generation 5 Tech. (GFIVU) 8670 Wolff Court Denver CO 80030 (303) 427-0055	To market computer-aided design systems and services.	$1.8 million from initial public offering	Frank Richardson, president	Computer Connection Ltd., president
GO 139 Townsend St. San Francisco, CA 94107 (415) 543-3200	To develop new software and hardware for personal computing, aimed at professionals and managers.	Undisclosed funding from Kleiner, Perkins, Caufield & Byers	Jerrold Kaplan, president, CEO Robert M. Carr, v.p. software	Lotus Development, principal technologist Ashton-Tate, chief scientist
Hecht-Nielsen Neurocomputer 5893 Oberlin Dr. San Diego, CA 92121 (619) 546-8877	To supply hardware and software for research and development of neural networks. First product—Anza neurocomputing coprocessor system—now on market.	Undisclosed funding from a venture-capital consortium	Robert North, president	TRW, v.p. Electronic Systems Group
I-Logix 22 Third Ave. Burlington, MA 01803 (617) 272-8035	To develop and market software for automating system development.	$3.25 million first-round financing	Peter A. Chiassan, president Shmuel Halevi, v.p.	Computervision, v.p. electronic systems Scitex, director of marketing
Materials Characterization Lab. 704 Corporations Park Scotia, NY 12302 (518) 346-6772	To provide specialized engineering services, including testing of structural materials.	$350,000 from Schenectady Trust and other sources	Ray Williams, president Wayne Andrews, v.p.	GE, Turbine Technology Lab, materials-testing engineer Knolls Atomic Power Lab., materials-testing engineer
Metheus (METH) 5510 N.E. Elam Young Hillsboro, OR 97124 (503) 640-8000	To design, manufacture, and sell computer graphics-display products.	$6.6 million from initial public offering	Gene Chao, president, CEO Thomas Hein, v.p. finance and administration	Tektronix, founder, Applied Research Group Memorex, finance manager, international group
StepperVision 329 N. Bernardo Ave. Mountain View, CA 94043 (415) 960-1176	To market the Stepper image monitor, a device that provides optimal settings for semi-conductor-production cameras that transfer design images onto silicon.	Undisclosed financing from test-site companies	Warth Z. Ludwick, president, CEO Shelby H. Carter Jr., chairman	Xerox, director, external-business development, Palo Alto Research Center Xerox, v.p.
Qubix Graphic Sys. (QBX) 1255 Parkmoore Ave. San Jose, CA 95126 (408) 292-4000	To produce graphics workstations for corporate, government, and commercial publishers.	$6.5 million from initial public offering	Neal Dempsey, president, CEO Timothy Conley, v.p. finance, treasurer	Envision Tech, president, CEO Zentech, senior v.p. finance
Unigene Labs. (UGNEU) 110 Little Falls Rd. Caldwell, NJ 07006 (201) 882-0860	To provide laboratory services for genetic engineering.	$11.5 million from initial public offering	Warren P. Levy, president	Roche Institute of Molecular Biology, postdoctoral fellow

CONTRACTS AWARDED

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Aerojet TechSystems Box 13618 Sacramento, CA 95853 (916) 355-1000	McDonnell Douglas	$65 million	To build engines for the Delta rocket, to be used by Nasa, the Air Force, and commercial customers.
Boeing Military Airplane Box 3707, M/S 4H-14 Seattle, WA 98124 (206) 655-1198	U.S. Air Force	$729,578	To study the effects of high-density fuels on aircraft performance and fuel-system components.
Boeing Military Airplane Box 3707, M/S 4H-14 Seattle, WA 98124 (206) 655-1198	U.S. Air Force	$425,000	To study avionic requirements for aircraft capable of speeds between Mach 4 and Mach 25.
Compunetics 2000 Elda Rd. Monroeville, PA 15146 (412) 373-8110	NASA	$4 million	To provide the switching network for the Goddard Space Flight Center in Greenbelt, Maryland.
Diagnostic/Retrieval Systems 16 Thornton Rd. Oakland, NJ 07436 (201) 337-3800	U.S. Navy	$25,000, with options to $40 million	To develop and supply acoustic video-processor integrated-display stations for antisubmarine warfare.
Digital Microwave 170 Rose Orchard Way San Jose, CA 95134 (408) 943-0777	E8 Nero	$8.1 million	To develop and manufacture a 15-gigahertz digital microwave radio.
Ecogen 2005 Cabot Blvd. West Langhorne, PA 19047 (215) 757-1590	Monsanto	$1 million	To create plants and bacteria that act as pesticides.
EG&G 45 William St. Wellesley, MA 02181 (617) 237-5100	U.S. Department of Energy	$2.25 billion	To continue operation, maintenance, and support for the Department's nuclear-weapons test program.
Fairchild Weston Systems 300 Robbins Lane Syosset, NY 11791 (516) 349-2219	Naval Training Systems Command	$1 million, with options to $11 million	To produce gunnery-training simulators for antitank missiles, working with Perceptronics Inc.
Georgia Institute of Technology Centennial Research Bldg. Atlanta, GA 30332 (404) 894-7046	U.S. Air Force	$3 million	To develop support programs for the Air Force's automatic test equipment software, used to check circuit cards in the F-16 jet fighter.
GE/RCA Government Services Route 38, Bldg. 201-3 Cherry Hill, NJ 08358 (609) 486-5174	U.S. Coast Guard	$42 million	To provide three surveillance-radar systems to detect small boats and aircraft as far away as 50 miles.
GTE 1 Research Dr. Westborough, MA 01581 (617) 366-6000	U.S. Air Force Systems Command, Electronic Systems Div.	$6.8 million, with $2-million option	To provide software development and a maintenance environment to modernize the Defense Department's automatic data-processing system.
Harris 1025 W. NASA Blvd. Melbourne, FL 32919 (305) 727-9126	U.S. Naval Training Systems Center	$1.1 million	To develop a computer-based trainer for catapult-launch systems on aircraft carriers.

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Honeywell/Aerospace 3600 West 80th St. Bloomington, MN 55431 (612) 921-3409	National Computer Security Center	$20.9 million	To design and implement a secure computer system that meets the center's highest security criteria.
Information Technologies 7850 E. Evans Rd. Scottsdale, AZ 85260 (800) 431-3460	International Technology	$1-million subcontract	To connect about 700 local-area networks to IBM mainframes for the Federal Bureau of Investigation, under International Technology's $133-million contract.
Intraspace 16354 Grayville Dr. La Mirada, CA 90683 (213) 947-8256	Starfind	$15 million	To design and develop five geolocation satellites as part of Starfind's worldwide location network.
Lightnet 600 E. Jefferson St. Rockville, MD 20852 (301) 738-8172	Dow Jones & Company	$3 million	To provide private-line data communications between Dow Jones' headquarters in New York and its printing plant in Chicopee, Massachusetts.
Lockheed Aeronautical Systems Dept. 72-93, Zone 365 Marietta, GA 30063 (404) 425-7773	U.S. Marine Corps	$575,000	To develop a prototype electronic-countermeasures system for the KC-130 Hercules tanker aircraft.
Lockheed Missiles & Space Box 3504 Sunnyvale, CA 94088 (408) 742-6688	NASA	$242 million	To automate the design and development of computer software for the space station.
Lockheed Missiles & Space Box 3504 Sunnyvale, CA 94088 (408) 742-6688	NASA	$5.5 million	To develop software and techniques for analyzing the structural designs of aerospace projects in the 1990s.
LTV Box 655003 Dallas, TX 75265 (214) 266-2543	U.S. Air Force	$9.4 million	To build an advanced spoiler for the F-111 airplane.
Metier Management Systems 2900 N. Loop West Houston, TX 77092 (800) 362-9118	Boeing	$400,000	To work on NASA's Technical Management Information System for the space station.
ORI/Calculon 2440 Research Blvd. Rockville, MD 20850 (301) 258-5300	U.S. Dept. of Housing & Urban Development	$4.4 million	To develop and maintain automated data-processing services for the department.
ORI/Calculon 2440 Research Blvd. Rockville, MD 20850 (301) 258-5300	U.S. Marine Corps	$3.6 million	To help the Marine Corps Development and Education Command develop and acquire ground and air combat systems.
Perceptronics 6271 Variell Ave. Woodland Hills, CA 91367 (818) 884-7470	Naval Training Systems Command	$11 million	To produce gunnery-training simulators for antitank missiles, working with Fairchild Weston Systems.
Spire Patriots Park Bedford, MA 01730 (617) 275-6000	U.S. Army/Ft. Monmouth	$50,000	To investigate mercury-manganese-telluride and mercury-zinc-telluride thin films.
Synercom Technology Box 27 Sugar Land, TX 77478 (713) 240-5000	The city of Nashville	Not disclosed	To provide a system to manage map information for the city's Metropolitan Area Geographic Information Consortium

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Synercom Technology Box 27 Sugar Land, TX 77478 (713) 240-5000	The city of Indianapolis	Not disclosed	To develop a system to manage automated-mapping information and facilities for the city.
Tracor Aerospace 6500 Tracor Lane Austin, TX 78725 (512) 929-2271	U.S. Army	$87 million	To modify the EH-60A aircraft with a Quick Fix System.
TRW 1 Space Park, E2/9085 Redando Beach, CA 90278 (213) 535-1568	NASA's Goddard Space Flight Center	$10 million	To design, build, and integrate a direct-detection laser transceiver.
Unisys/Defense Systems Box 500 Blue Bell, PA 19424 (703) 847-3375	Environmental Protection Agency	$80 million	To provide automated support for the EPA's National Data Processing Division.
UTC/Optical Systems 2111 Wilson Blvd. Arlington, VA 22200 (703) 284-1800	MIT's Lincoln Laboratory	$4.5 million	To develop the next generation of fast steering mirrors for high-energy laser-beam control systems.
UTC/Pratt & Whitney Box 109600 West Palm Beach, FL 33410 (305) 840-2445	U.S. Air Force	$81 million	To continue development work on the propulsion system for the National Aerospace Plane.
UTC/Pratt & Whitney Box 109600 West Palm Beach, FL 33410 (305) 840-2445	U.S. Navy	$1.7 million	To develop the PW1212 jet engine, a 12,000-pound-thrust derivative of the J52 turbojet engine.
Utility Graphics Consultants 6200 S. Syracuse Way Englewood, CO 80111 (303) 773-6166	Salt River Project	Not disclosed	To provide consulting services for a project to manage automated-mapping and electric-distribution facilities.

JOINT VENTURES

COMPANY	COMPANY	PURPOSE	CONTACT
BioTechnica	RJR Nabisco	To develop better food crops through genetic engineering.	BioTechnica 85 Bolton St. Cambridge, MA 02140 (617) 864-0040
Compugraphic	Hewlett-Packard	To develop technology for electronic publishing, pursue industry standards, and promote marketing opportunities.	Compugraphic 200 Ballardvale St. Wilmington, MA 01887 (617) 658-5600
Tandon	Western Digital	To manufacture and market 3½-inch intelligent Winchester disk drives for personal computers.	Tandon 20320 Prairie St. Chatsworth, CA 91311 (818) 993-6644
Timeplex	Comsat General	To form Safecom Partners, a company to provide low-cost T-1 satellite transmission for backup, overflow, and alternate-routing services.	Timeplex 400 Chestnut Ridge Rd. Woodcliff Lake, NJ 07675 (201) 391-1111
United Technologies Automotive	Commercial Shearing	To manufacture and sell electrohydraulic motors and pumps for anti-lock brake systems and other applications.	United Technologies 5200 Auto Club Dr. Dearborn, MI 48126 (313) 593-9925

MERGERS

COMPANY	BUSINESS	COMPANY	BUSINESS	NEW NAME
ICF 1850 K St. NW Washington, DC 20006 (202) 862-1100	Consulting	Lewin and Associates 1090 Vermont Ave. NW Washington, DC 20005 (202) 842-2800	Consulting	Not available
Westmark Systems 301 Congress Ave. Austin, TX 78701 (512) 322-0222	Holding company	Tracor 6500 Tracor Lane Austin, TX 78725 (512) 926-2800	Defense electronics, analytical instruments, and electronic components	Tracor becomes a wholly owned subsidiary of Westmark but retains its name.

ACQUISITIONS

BUYER	BUSINESS	COMPANY ACQUIRED	BUSINESS	AMOUNT
Arrow Electronics 25 Hub Dr. Melville, NY 11747 (516) 391-1300	Electronics distribution	Kierulff Electronics 10824 Hope St. Cypress, CA 90830 (714) 220-6300	Electronics distribution	$130 million
EG&G 45 William St. Wellesley, MA 02181 (617) 237-5100	Scientific instruments; electronic components; testing; site management	Judson Infrared 221 Commerce Dr. Montgomeryville, PA 18936 (215) 368-6900	Infrared and fiber-optic components	Not disclosed
GigaMos Systems 650 Suffolk St. Lowell, MA 01854 (617) 458-9100	Artificial intelligence	Lisp Machines 650 Suffolk St. Lowell, MA 01854 (617) 458-9100	Artificial intelligence	Not disclosed
Medtronic 7000 Central Ave., N.E. Minneapolis, MN 55432 (612) 547-4000	Implantable biomedical devices	Johnson & Johnson Cardiovascular Div. 1 Johnson & Johnson Plaza New Brunswick, NJ 08933 (201) 524-0400	Cardiac-surgery products	Not disclosed
Microsemi Box 26890 Santa Ana, CA 92799 (714) 878-8220	Semiconductor products and assemblies	Salem Scientific 72 Cherry Hill Dr. Beverly, MA 01915 (617) 927-5820	Semiconductor-die processing and custom packaging	Not disclosed
Orion Network Systems 1995 University Ave. Berkeley, CA 94704 (415) 649-4000	Network software	X.Dot 1995 University Ave. Berkeley, CA 94704 (415) 649-4000	Open Systems Interconnect (OSI) software	Not disclosed
Osicom Technologies 198 Green Pond Rd. Rockaway, NJ 07866 (201) 586-2550	Electronics distribution	Atlanta Disk & Peripheral 3260 Satellite Blvd. Duluth, GA 30136 (404) 476-5444	Electronics distribution	Not disclosed
Prime Computer Prime Park Natick, MA 01760 (617) 655-8000	Computers	Versacad 7372 Prince Dr. Huntington Beach, CA 92647 (714) 847-9960	Computer-aided design software	Not disclosed
Scientific Micro Systems 339 N. Bernardo Ave. Mountain View, CA 94043 (415) 964-5700	Data controllers, software, and application-specific integrated circuits	Diego Levco 6160 Lusk Blvd. San Diego, CA 92121 (619) 457-2011	Macintosh-enhancement products	Not disclosed
Top Hat Systems 2422 Rand Morgan Corpus Christi, TX 78410 (512) 241-6110	Food-service industry software	Rest Systems 2422 Rand Morgan Corpus Christi, TX 78410 (512) 241-6110	Restaurant-management software	Not disclosed

THE HIGH TECHNOLOGY BUSINESS LEADING 100

COMPANY (SYMBOL)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE		LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
				LAST QUARTER ($)	CHANGE FROM 1 YEAR AGO				
AEROSPACE									
Singer (SMF)	1/*	18.0	54.00	-.90	-100.0	40	26.6	.53	1,800.8
Atlantic Research (ATRC)	2/*	14.1	28.25	.59	5.4	—	15.2	.45	337.5
Fairchild Ind. (FEN)	3/8	11.0	15.13	.59	NE	.20	NE	4.49	628.3
Watkins Jahnsan (WJ)	4/9	6.9	36.75	.45	-16.7	.40	19.1	.26	256.2
Sundstrand (SNS)	5/*	6.3	61.00	.72	-31.4	1.80	29.3	.49	1,399.2
AAR (AIR)	6/*	5.2	35.25	.44	33.3	.50	21.9	.09	306.0
Hexcel (HXL)	7/6	4.7	55.88	.75	23.0	.60	23.1	.87	319.7
Narthrap (NOC)	8/*	4.7	47.38	-.33	-100.0	1.20	NM	.04	5,735.4
Gen. Matars H. (GMH)	9/*	4.5	49.63	NA	NA	.72	NA	NA	NA
Kaman A. (KAMNA)	10/*	3.4	3D.25	.54	14.9	.64	15.2	.55	644.4
CHEMICALS									
Lawter Int. (LAW)	1/*	32.3	20.50	.23	27.8	.56	24.7	.09	106.3
Fst. Miss. (FRM)	2/*	29.1	17.75	.48	NE	.24	19.1	.58	278.9
Polymeric Rsc. (POLR)	3/*	28.9	5.00	.10	25.D	—	14.3	1.28	13.8
Cabat (C8T)	4/*	26.9	48.38	.53	10.4	.92	19.5	.72	1,254.6
Ecogen (ECN)	5/*	25.1	8.13	.03	NE	—	NE	.25	3.1
Airgas (AGA)	6/*	21.0	15.13	.16	14.3	—	24.4	3.08	116.9
Loctite (LOC)	7/*	17.1	65.00	1.05	18.0	1.00	19.2	.09	337.8
MacDermid (MACD)	8/*	11.2	34.75	.47	30.6	.52	21.7	.24	100.6
Dexter (DEX)	9/*	11.1	30.00	.50	38.9	.60	19.5	.44	710.0
Grt. Lks. Chem. (GLK)	10/*	9.5	70.50	.72	53.2	.64	28.5	.75	378.6
COMMUNICATIONS									
MCI Camms. (MCIC)	1/*	35.8	11.88	.02	-66.7	—	NE	2.12	3,737.1
Digital Micrawave (DMIC)	2/*	14.1	20.25	.12	500.0	—	59.6	.14	25.7
ADC Telecam. (ADCT)	3/9	10.1	30.00	.53	47.2	—	19.4	.06	158.9
NW Telecam. (NOWT)	4/*	8.8	21.75	.31	106.7	.92	11.9	2.88	41.1
Pac. Telesis (PAC)	5/*	8.7	31.25	.57	-13.6	1.64	12.7	.71	8,975.9
Swtrn. Bell (SBC)	6/*	8.3	42.50	.83	-4.6	2.32	12.4	.63	7,740.2
Netwark Equip. (NETX)	7/*	7.9	24.00	.14	180.0	—	77.4	.10	52.9
SauthernNet (SOUT)	8/*	7.1	22.50	.16	.0	—	NE	.27	174.1
Pac. Telecam. (PTCM)	9/*	6.9	15.50	.22	-31.3	.88	15.3	.80	501.0
Millicam (MILL)	10/*	6.1	19.50	-.21	-100.D	—	4.1	—	77.9
COMPUTERS									
Pyramid Tech. (PYRD)	1/*	45.2	11.25	.D5	NE	—	NE	.03	49.3
Inacamp Camputers (INAC)	2/*	44.2	11.00	.09	350.0	—	24.4	.54	187.8
Valid Logic (VLID)	3/*	38.7	5.38	-.14	-100.0	—	NE	.08	59.0
Dest (DEST)	4/*	36.5	7.0D	.03	NE	—	NE	.27	21.7
Campaq Cptr. (CPQ)	5/*	35.9	77.13	.81	138.2	—	34.3	.40	812.6
Sigma Designs (SIGM)	6/*	32.3	20.50	.25	212.5	—	22.5	—	39.4
DH Tech (DHTK)	7/*	30.4	7.50	.16	45.5	—	14.2	.01	17.2
Intermec (INTR)	8/*	28.5	18.63	.15	15.4	—	27.8	—	67.7
Copytele. (COPY)	9/*	27.8	12.38	-.05	NE	—	NE	—	.1
Genicam (GECM)	10/*	27.0	13.50	.23	4.5	—	15.5	.36	224.0
DRUG MANUFACTURERS									
Biacraft Labs (BCL)	1/*	36.0	27.88	.35	483.3	—	34.8	.05	69.3
MedChem Prads. (MDCH)	2/*	34.6	17.50	.20	122.2	—	27.8	.02	7.2
Synbiatics (SBIO)	3/*	22.6	9.50	.09	NE	—	73.1	.05	5.8
Malecular Biasys. (MOBI)	4/*	20.4	14.00	—	-100.0	—	NE	.D1	1.8
T Cell Sciences (TCEL)	5/*	17.1	4.25	-.05	NE	—	NE	—	3.8
Utd. Guardian (UNIR)	6/*	12.3	10.25	-.02	NC	—	NE	.24	5.1
Callabarative Rsh. (CRIC)	7/*	10.3	8.00	-.04	NC	—	NE	—	10.2
Adv. Magnetics (ADMG)	8/*	9.4	8.75	.16	220.0	—	25.7	—	4.4
Amgen (AMGN)	9/*	9.0	33.25	.02	-33.3	—	NM	.08	35.9
Hycar Biamed. (HYBD)	10/*	8.7	1.63	.02	NE	—	81.3	.08	6.8

The following are the 10 companies in each of 10 industries that had the highest stock gain over the previous month (figures as of 10/9/87).

NE = Negative earnings NC = Not calculable NM = No meaningful figure * = Not among Leading 100 last month

COMPANY (SYMBOL)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE		LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
				LAST QUARTER ($)	CHANGE FROM 1 YEAR AGO				
ELECTRONICS									
Interand (IRND)	1/*	69.2	5.50	-.24	NE	—	NE	.13	4.1
VMX (VMXI)	2/*	47.5	3.88	.05	NE	—	NE	—	30.0
ILC Tech. (ILCT)	3/*	39.1	8.00	.17	NE	—	NE	.47	30.7
ICOT (ICOT)	4/*	33.3	8.00	.02	-85.7	—	22.9	.03	49.7
Micron Tech. (ORAM)	5/*	33.0	15.63	.06	NE	—	NE	.31	91.2
Silicon Systs. (SLCN)	6/*	31.4	14.63	.11	37.5	—	31.1	1.33	77.4
Microsemi (MSCC)	7/*	30.8	10.63	.14	-12.5	—	18.0	.22	42.5
Wall to Wall Snd. (WTWS)	8/*	29.6	6.00	NC	NC	—	11.1	—	NC
Technic. Comm. (TCCO)	9/6	29.4	5.50	-.14	NE	—	NE	—	3.5
Marshall Ind. (MI)	10/*	27.8	23.00	.43	186.7	—	23.7	.76	305.6
HEALTH									
Inmed (NMEOE)	1/*	85.7	3.25	-.02	NE	—	NE	.39	9.2
Electro Biology (E8II)	2/*	45.8	6.75	.02	-88.9	—	30.7	.01	36.0
Dento. Med. (OTMD)	3/*	28.0	2.88	-.02	NE	—	NE	—	.1
Span. Amer. Med. (SPAN)	4/*	27.1	5.25	.10	NE	—	19.4	.80	14.3
Damon (OMN)	5/*	26.2	19.25	.16	NE	.20	NM	.51	167.9
MOT (MOTC)	6/*	23.3	7.25	.06	.0	—	27.9	—	12.2
Novametrix Med. (NMTX)	7/*	21.8	8.38	.05	.0	—	46.5	.16	17.2
Vipont Pharm. (VLA8)	8/*	19.9	24.88	.21	950.0	—	63.8	—	20.2
Phone o Gram (PHOG)	9/*	19.8	3.75	-1.77	NE	—	NE	5.67	5.8
Circadian (CKDN)	10/*	18.2	3.25	.03	-70.0	—	21.7	—	20.4
METALS FABRICATION									
Redlaw Ind. (RDL)	1/*	28.9	5.00	.23	43.8	—	6.3	.24	71.0
Met-Coil Sys. (METS)	2/*	25.0	7.50	.11	-65.6	.12	35.7	.64	50.4
Reuter (REUT)	3/*	16.0	14.50	-.54	-100.0	—	40.3	.52	24.9
Coml. Shearing (CSHR)	4/*	9.2	17.88	.31	10.7	.56	20.3	.68	311.7
Douglas Lamoson (DOUG)	5/*	9.1	21.00	.88	6.0	.50	11.4	.68	290.6
Steel Tech. (STTX)	6/2	8.0	30.50	.15	-31.8	.02	31.4	.12	78.9
Synolloy (SYO)	7/1	7.2	5.50	-.07	-100.0	—	NE	.20	47.5
MLX (MLXX)	8/8	7.1	7.50	.09	350.0	—	NE	6.36	252.0
Fansteel (FNL)	9/*	6.6	16.25	-.04	-100.0	.60	NM	.26	186.9
Vorlen (VRLN)	10/*	5.1	15.50	.45	25.0	.60	15.2	.81	135.8
SCIENTIFIC AND ELECTRONIC INSTRUMENTS									
Vonzetti Sys. (VANZ)	1/*	39.1	3.13	-.33	NE	—	NE	.25	2.9
Hach (HACH)	2/*	16.1	18.00	.22	37.5	.20	24.7	.12	43.3
Brinkmann Inst. (BRIK)	3/*	15.2	11.38	.22	37.5	—	17.0	—	57.9
EIP Microwave (EIPM)	4/*	15.2	9.50	.03	50.0	.12	79.2	.24	20.7
Finnigan (FNNG)	5/*	13.4	19.00	.16	300.0	—	NE	.36	92.1
CEM (CEMX)	6/*	11.5	14.50	.17	30.8	—	25.9	—	9.8
Resource Eng. (RSE)	7/9	11.1	18.75	.10	66.7	—	56.8	2.05	42.2
Energy Conv. Dev. (ENER)	8/*	10.6	18.25	.54	NE	—	NE	1.40	19.6
Sec. Tog Sys. (STAG)	9/*	10.5	2.63	.01	NC	—	NE	.08	5.7
FBX (FBXC)	10/*	9.5	4.25	.02	-33.3	—	42.5	.17	13.3
SOFTWARE AND DATA PROCESSING									
Oyatron (DYTR)	1/*	92.9	13.50	.19	NE	—	18.0	.12	34.9
Adv. Comp. Tech. (ACTP)	2/*	65.3	6.00	.02	-88.2	—	24.0	.34	14.7
Gen. Computer (GCCC)	3/*	42.9	12.50	.13	30.0	—	28.4	—	15.5
Corporate Sftwre. (CSOF)	4/*	36.4	11.25	.16	NC	—	17.9	.07	32.0
Hadron (HDRN)	5/*	31.1	1.56	.03	50.0	—	26.0	.85	26.3
Oracle Sys. (ORCL)	6/*	31.0	33.25	.10	900.0	—	56.4	.20	155.0
ECAD (ECAD)	7/*	30.4	11.25	.09	125.0	—	51.1	.50	19.1
Samna (SMNA)	8/*	30.0	9.75	.21	110.0	—	18.4	—	9.1
Continuum (CTUC)	9/*	29.1	27.75	.12	-20.0	—	38.5	.45	58.6
Daisy Sys. (DAZY)	10/*	28.6	9.00	-.59	NE	—	NE	—	98.2

SOURCE: MEDIA GENERAL FINANCIAL SERVICES

RESEARCH REPORTS

STUDY BY	TITLE	FORECAST	PRICE
DataQuest 1290 Ridder Park Dr. San Jose, CA 95131 (408) 971-9000	The IBM 3270 Marketplace: 1987 and Beyond	Analyzes market potential of IBM's 3270 computer and emulation boards; discusses factors necessary for success in that market.	$1,995
Electronic Trend Publications 12930 Saratoga Ave. Saratoga, CA 95070 (408) 996-7416	Power-Hybrid Markets and Applications	Consumption of power hybrid circuits by U.S. original-equipment manufacturers will reach $392.5 million by 1991, an annual increase of 16%.	$6,000
Freeman Associates 311 E. Carrillo St. Santa Barbara, CA 93101 (805) 963-3853	Computer Tape Outlook	The low-end market for half-inch cartridge tape drives will exceed $1.2 billion in 1992, for an expected revenue of $533 million. High-end market will reach $735 million in 1992.	$1,495
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	The U.S. Commercial Market for Image-Processing Systems (#A1771)	The market will grow from $470.4 million in 1986 to $1 billion by 1992.	$1,950
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	The Analog-to-Digital and Digital-to-Analog Conversion Components Market in the U.S. (#A1781)	Annual growth will occur at a rate of 19%, with U.S. sales of $1.4 billion by 1990.	$1,950
Input 8298-C Old Courthouse Rd. Vienna, VA 22180 (703) 847-6870	Federal Government Professional-Services Markets, 1986-1991	Federal use of professional services will reach $5.5 billion in 1991. The biggest gainer, systems integration, will grow from $900 million in 1986 to $1.6 billion.	$1,395
Input 1280 Villa St. Mountain View, CA 94041 (415) 961-3300	Electronic-Data-Interchange Software Markets, 1987-1992	The market for electronic-data-interchange software will grow 55% annually, to $88.2 million by 1992.	$1,250
Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	The Blood-Bank Industry (#A17.5)	Highlights growth markets for instrumentation that tests for infectious diseases such as AIDS and hepatitis. Includes market forecasts to 1993.	$995
Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	Midrange Computer Markets (#A229)	Worldwide market for minicomputers and superminicomputers will top $20 billion by 1988, $40 billion in 1992, and $49 billion in 1993.	$995
Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	Orthopedic-Product Markets (#A181)	Sales of arthroscopy systems will reach $135 million by 1993.	$995
Ovum 601 Ewing St. Princeton, NJ 08540 (609) 921-6886	Broadband Communications: The Commercial Impact	By 1995, about 3% of businesses will have access to fiber-optic networks. By 2000, 16% will have access and broadband services will bring in 7% of carrier revenues.	$495
Personal Technology Research Box 3390 Boston, MA 02101 (617) 232-6318	Personal Facsimile: Strategies for Reaching the Critical Mass	Growth of sales of facsimile machines will exceed 400% during the next five years, the major market being small businesses.	$2,395
Theta Theta Building Middlefield, CT 06455 (203) 349-1054	Biomedical Fermentation Market (#711)	To remain competitive, makers of biomedical fermenters and cell-culture bioreactors must provide a variety of services and consulting support. Forecasts to 1990.	$795

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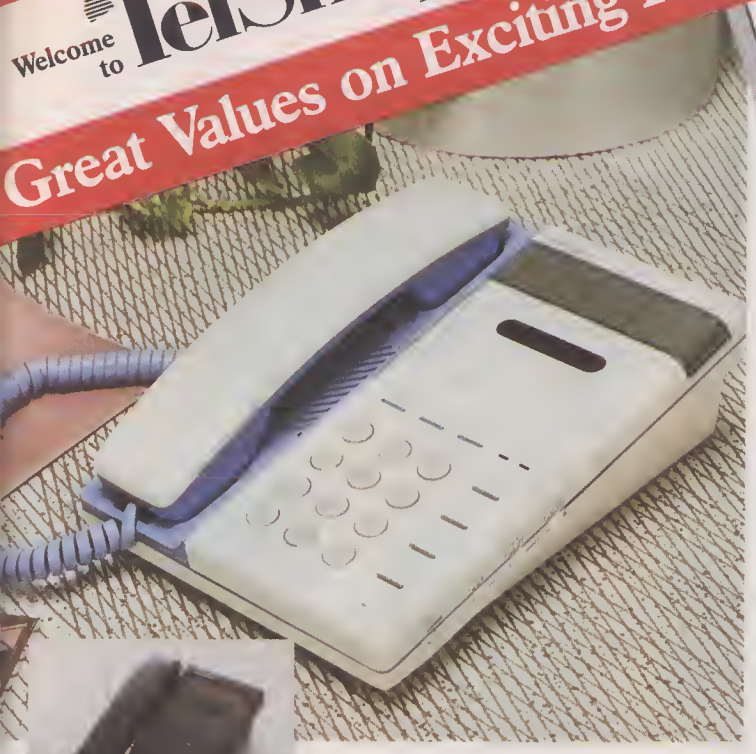

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The Answer You Wanted to Hear

A. Sharp's new line of combination telephone and answering systems (model no. FP700) will make it seem like there's a receptionist in your home. Advanced features include IC recording chip, which makes for improved voice reproduction and eliminates the need for a second microcassette tape, thus clearing out space for more convenience features. And the list is long, including local message memo, on-line conversation record, call screening and select call. Sharp has designed this advanced machine for ease of operation, with beeperless remote, 12 auto dial memory and pulse/tone switchable. Available in blue/white or black. 6 5/16"W × 3 15/16"H × 8 11/16"D.

RT001 Retail 239.95
Telshop price 149.95 (4.95)
Save 90.00

A.

Wake up to Great value

B. Radio, cassette tape or buzzer—three ways to start a new day are all at your fingertips with Sharp's new AM/FM digital clock radio (model no. FXC100) with cassette player and auto stop. Large, easy to read green LED display tells you the time from virtually any angle, while battery back up ensures uninterrupted operation. Best of all, the unit comes with a 59-minute sleep timer for those who just can't give up the mattress! 9 11/16W" × 4 1/8"H × 4 3/4"D.
RT002 Retail 64.95
Telshop price 49.95 (4.75) **Save 15.00**

B.

Detectable Quality

C. Make tracks but do so discreetly with Rally's super compact radar detector (model no. XK500). About the width of your key chain, this radar detector comes standard with features normally found in much higher end units. The heart of the unit is the dual conversion X & K bands superheterodyne technology, which gives you complete cover from both of the frequencies police transmit on to snare speeders. Other features include LED signal strength meter, city/highway switch, variable volume control and dash visor mounting bracket. All at a s-low, s-low price! 3 1/4"W × 7/8"H × 4 3/4"D.
RT003 Retail 119.95
Telshop price 69.95 (3.95)
Save 50.00

C.

CALL TOLL FREE
1-800-962-2962

Complete Entertainment Center

A.

A Sound Viewing Experience

A. Sharp's new 140-channel cable capable 20-inch Super VHS compatible monitor/TV (model no. 20MV97) set is absolutely state of the art. Flat, square, tinted picture tube is capable of up to 400 lines of horizontal resolution when used with Super VHS. By contrast, regular TV broadcasts at 320 lines while the average VCR tunes in at a mere 270 lines. You'll be wondering how such exhilarating audio and clear, bright images can come out of such a compact unit. The answer: a built-in MTS (multi-channel TV sound) stereo decoder and two-way two-speaker stereo. But that's not all you get for this great price, because the 26-function solar powered infrared remote needs no batteries. And, on screen display indicates channel, time of day, volume and minutes remaining on sleep timer. Includes A/V jacks for easy computer hookup. 23 15/32"W × 22 43/64"H × 22 1/4"D.
RT004 Retail 799.00
Telshop Price 549.00 (20.95)
Save 250.00

C.

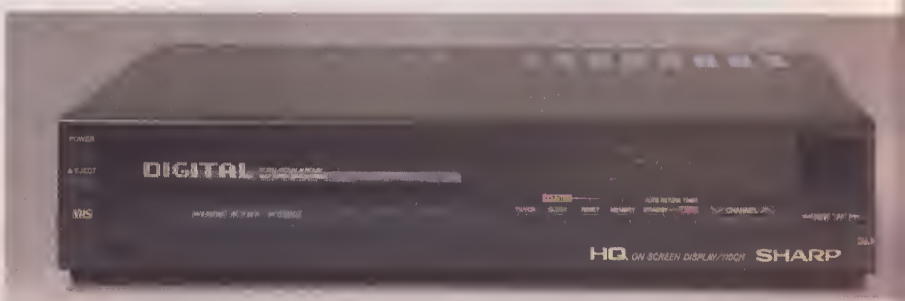
Well-Done Rack of Sound

C. Sharp has delivered the best affordable sound system (model no. Z1000-DX) on the market today. The heart of the system is a **monster receiver** that puts out 120-watt minimum per channel into 8 ohms from 40 Hz to 20,000 Hz with no more than 0.5% total harmonic distortion. The receiver includes 7-band graphic equalizer *and* 7-band spectrum analyzer to permit precise calibraton of the sound to the listener's sonic tastes and to individual room acoustics. A **compact disc player** with 20 random access programming and 3-beam laser pick-up produces crisp, clear sound, while a **digital synthesized tuner** with 14 station presets and auto scan finds the station for you and then locks it in. Rounding out the system are a semi-automatic belt driven **turntable** and **dual cassette deck** with high speed dubbing continuous playback and DOLBY noise reduction. And topping it all off are a **pair of speakers** that will surely bring music to your ears. A specially developed three-way system, each speaker contains a 5-inch midrange and dome type tweeter, **anchored by a 10-inch down firing super woofer** that disperses rich, powerful bass evenly to all parts of the listening room. A package hard to beat at twice the price!
Rack 20 1/8"W × 40 5/8"H × 16 9/16"D. Speakers 13 7/16"W × 41"H × 13 7/16"D.
RT006 Retail 1349.95 Telshop Price 995.00 ($75 truck) **Save 354.95**

Picture Perfect Video Cassette Recorder

E. Do you often wish you could view several channels at once? Your wish has been granted by Sharp's new 110 channel cable ready digital special effects two-head VCR (model no. VCD800U) with its 9 picture on screen and channel search with picture in picture. VHS HQ circuitry with double comb filter ensures vivid, razor sharp picture. Standard equipment also includes TV strobe slow motion playback and still function for matchless slow motion and freeze frame; random access tuner for instant channel switching; 14-day, two-event programming; 35-function wireless remote and two-speed video search. And Sharp has included some nice little extras: on screen timer programming display and blue screen noise elimination system. 17"W × 4"H × 13 3/4D.

RT008 Retail 499.00
Telshop Price 399.00 (11.95)
Save 100.00



E.

CALL TOLL FREE
1-800-962-2962

A Little Travelin' Music

D.

D. Compact-disk quality sound to go is now a reality with Sharp's new feather-like 12 pound totable unit (model no. WQCD30). But you're not limited to CDs only, because Sharp added twin cassette decks with continuous playback from tape one to tape two, as well as high speed dubbing. The side-to-side placement of the cassette decks has twin benefits. One, it allows for a much smaller unit and two, it reduces distortion when recording from one tape to another since all heads are located on one capstan. Rounding out a great sound package are a 3-band graphic equalizer and a super sensitive AM-FM stereo radio. This pleasure machine would make a superb gift to give—and to receive! 23¼"W × 5⅝"H × 7⅝"D.
RT007 Retail 419.95 Telshop price 249.95 (5.95)
Save 170.00

User-Friendly Camcorder

F.

F. Ease of operation and up-to-the-minute technology converge in Sharp's new miniature camcorder (model no. VLC73UA). Sharp wanted to design a camcorder that would be simple enough to be used with great results by novices, yet with enough professional quality options to meet the needs of video mavens. Mission accomplished. Most important, easy-to-use ½-inch VHS-C cassettes are fully compatible with VHS recorders once tape is placed in an adaptor included with the unit. Video sophisticates will warm to the high speed electronic shutter with 1/1000th second shutter speed, variable 8x power zoom lens, sound track mixing, HQ system quality plus CCD image sensors and full auto white balance, auto iris, auto date and auto power off. Neophytes will enjoy the automatic focus, which allows the user to simply aim and shoot. Everybody will relish the super-SHARP images. 5 lbs.
RT009 Retail 1599.00
Telshop price 1199.00 (5.95) **Save 400.00**

Performance Video on a Shoestring

B. You probably thought a performance-oriented VCR at a reasonable price was thoroughly impossible? It was—until Akai developed this new model (model no. VS-M910-UB), which, in critical ways, is identical to Akai's costliest units. DX4 four head double azimuth system with HQ circuitry provides highest quality reproduction and super-sharp analog special effects, and is programmable for six broadcasts over two weeks. Other standard features include VHS "HI-FI" with MTS stereo, 167 channel cable ready tuner; the world's first VHS quick start system with index and address search; super clear slow motion, still frame and frame advance. And for those who like to see the results of their efforts, Akai designed this super sophisticated unit with on-screen programming. Now, setting the channel and timer's problem free! 15.2"W × 3.6"H × 14.3"D.
RT005 Retail 749.00
Telshop price 599.00 (11.95) **Save 150.00**

B.

CALL TOLL FREE
1-800-962-2962

A.

Packard-Bell 1, IBM 0

A. Packard-Bell's powerful, full featured personal computer (model no. VX88F/1420) is IBM PC XT compatible, but that's where the similarities end. The VX-88 leaves Big Blue in the dust, in speed, memory, economy, performance and size. Unit comes complete with color monitor, built in color graphics, a 360K floppy disk drive, and 640K of RAM memory, a 20 Mb hard disk drive, GW basic and AT style keyboard. And it operates at either 5.5 or 8 MHz, compared with the XT's 4.77 MHz. You'll appreciate its 14.45-inch width—a full five inches less than the IBM. But that's still not all. Large 14 inch RGB color graphics monitor with .43 dot pitch is easy on the eyes and makes any type of computer operation, from word processing to games playing, a pleasurable experience.
RT010 Retail 2198.00
Telshop price 1395.00 (19.95)
Save 803.00

B.

It's a Clean Machine

B. Say goodbye to computer and office equipment down time caused by dust, staples, and other intruders that can creep in and damage the works. Data-Vac (model no. MDV-1), the first hand-held, high powered electric vacuum/blower system designed exclusively for computers and office equipment, is used by government services and field maintenance technicians. Data-Vac comes complete with crevice tool, air "pin pointer," finishing soft bristle brush, easy carry shoulder strap and five standard disposable paper bags. Lightweight all-steel vacuum blower power unit runs on 1.73 amps and has a hefty 200 watts of suction power. Flexible 19-inch hose will ensure that no speck goes undetected! 16" length.
RT011 Retail 87.00 Telshop price 49.95 (5.95) **Save 37.05**

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COMPANY INDEX

The following is a list of companies mentioned in this issue and the pages on which they appear. Companies mentioned in the High Technology Business Leading 100, New Products, and the Star Wars survey are not included.

Fun Software, a Faster Fax

OFFICE

On-line art for desktop publishers

NEED HELP getting your desktop-publishing system off the ground? A company based in San Francisco gives graphic artists on a low budget inexpensive access to costly publishing resources.

"Desktop publishing can be a mixed blessing," says Bruce Ryon, president of Design Access. Graphic artists are not always familiar with computers, and computer users are usually not skilled graphics designers. To address this problem, the company helps people decide what equipment they need, provides software and hardware, and teaches them how to use their systems. Products and services include libraries of clip art, a dial-up communications network that provides different type styles, desktop-publishing software that can be sent to users via telephone, document and art scanning, overnight typesetting, and publication design.

The initial $40 fee sets up an account that entitles subscribers to a quarterly newsletter. Every hour of communication costs $10, and software, typesetting, and scanning are extra. Equipped with 24 multiuser phone lines, Design Access specializes in Macintosh and AST Research equipment. Subscribers also can communicate with other subscribers by electronic mail or modem. Design Access is located at Ghirardelli Square, 900 N. Point, San Francisco, CA 94109. Telephone (415) 885-3156.

Desktop publishers get instant assistance.

HOME

Training power lunchers

A COMPUTER game with an already popular title—What They Don't Teach You at Harvard Business School—is being used as a training tool by Digital Equipment Corp. and New England Telephone.

In addition to being entertaining, the game is designed to help people become more effective managers. It uses management principles from Mark McCormack's best-selling book, which has the same name as the game, as well as methods taught at leading business schools.

Developed by Reality Technologies, the program runs on IBM and compatible personal computers; an Apple version is being developed. Players pose as managers of a sports marketing firm—a business that's "fun without being tedious," says Mark Goldstein, Reality's president. Through a series of simulated encounters—business meetings, power lunches, and the like—players try to meet the right people and set up business opportunities. Feedback on each decision is available immediately from "Coach McCormack," whose advice appears on screen in a pop-up window. Throughout the game, he assesses the players' performance.

The program retails for $50. Reality Technologies is located at 3624 Market St., Philadelphia, PA 19104. Telephone (800) 346-2024.

Computer game teaches management skills.

MARJORIE NICHOLS

OFFICE

Better fax reaches Japan

FOR THE growing number of executives who communicate extensively with Japan, a new service from RCA Global Communications promises to eliminate many of the problems that plague international facsimile (fax) transmission. Dubbed FaxForward, the service has been available since September.

ARMANDO DIAZ

Because regular international fax messages share space on conventional telephone lines, they often come out garbled and are prone to disconnections and slow transmissions that can cost time and money. RCA claims to solve these problems by serving as a clearinghouse for its customers' fax transmissions to Japan. Using a FaxForward phone provided by RCA, people send a fax and its destination number to the service's central computer. There the message is packaged for transmission across the Pacific via dedicated circuits. In Japan, a receiving station routes the fax to its recipient.

RCA claims that FaxForward costs 40 percent less than ordinary international fax transmission. The rate is $2.15 for the first minute and 80 cents for each additional minute, with a $400 minimum each month.

RCA Global Communications is located at 201 Centennial Ave., Piscataway, NJ 08854. Telephone (201) 885-2236.

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We'll target your corporate image, message, and products to generate the maximum response from investors.

We can take your company's marketing ideas, create, write, produce and broadcast guest interviews and commercial spots that can put your corporation in touch with interested investors.

On cable television, we can place nationally on CBN, ESPN, USA, Nashville, CNN, FNN, Arts, Lifetime, Weather, Discovery, Tempo, and Learning networks, your own commercial or one we produce for you. On radio, we use nationally Mutual, Westwood One and NBC networks.

- **Guest Interviews** Your company's ideas discussed and broadcast for 4 minutes on "Financial Inquiry," our program on the Learning Channel, $150 per run, using any 800 number for direct response. On FNN ("Take 5") we can place that interview for $500 to $2400 per run, plus talent fee, and production expenses.
- **Commercial Spots** Your company's 30, 60, and 120 second color spot can be strategically placed on cable television, and radio, for $150 to $2000 per run; costs vary by the network, length, time, day, and frequency, using any 800 number. TV commercials produced in our L.A. studios for approximately $2500, includes talent.
- **Investor Leads** We produce daily direct response potential investor leads from our own "Financial Inquiry" program and commercials run on all the cable networks with NICE 800 operators screening respondents for specific information.
  - **Solo**—exclusive use leads $28 ea. and up.
  - **Semi Solo**—multiple use leads $20 ea. and up.
  - **Multiple**—general use leads $15 ea. and up.

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CALL us for media information and let us help your company get in touch with interested investors.

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